

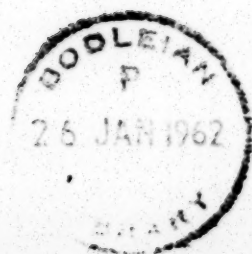
A NEW
Rational Anatomy,
Containing an
EXPLICATION
Of the USES of the
STRUCTURE
OF THE
Body of Man
And some other
ANIMALS,
According to the Rules of
MECHANICKS.

By *Daniel Taurvy*, a Member of the Colledge
of Physicians at *Paris*.

Made English from the third Edition. Revis'd, Corrected,
and Enlarg'd by the Author.

Illustrated with Sculptures.

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The Author's

P R E F A C E.

T*His Treatise is an Application of the Physicks and Mechanicks to the structure of Man's Body. It contains a brief description of the Figure, Scituation, Structure and Connexion of every part, as well as the nature of its Action. But in regard, the Organs of Brutes are much different from those of Men, though employ'd in the same Functions, I thought it not improper, to allot them a particular description, in order to set forth the various means by which Nature compasses the same end. Besides, a narrow view of the Structure of Irrational Animals, may serve to illustrate some hidden Springs in Humane Bodies. To this Comparative Anatomy, we owe most of our knowledge of the Oeconomy of the Body. The Circulation of the Blood, the Course of the Chyle, and the Passage of the Lymph, are discoveries deriv'd from it. Upon these Considerations, the digressions I have made upon the Machine of Irrational Animals, will be found not unserviceable, since they serve to illustrate the Machine*

The Author's Preface.

chine of Man's Body. Experience will justify what I advance as matter of Fact : And when I propose any thing that's uncommon, I insist more largely upon its Proofs and Circumstances.

I consider Man's Body, as being a Statick, Hydraulick, and Pneumatick Machine ; of which the Bones are the Levers and Supporters, the Muscles the Strings, the Lungs the Pumps, and the Vessels the Pipes, in which the Liquors have a perpetual Circulation. For, 'tis a certain truth, that, if those who enquire into the uses of the parts, had always compar'd the Body to Machines, and explain'd the hidden operation of the parts, by the known and demonstrated actions of Mechanism, they had succeeded better in their attempt.

Perhaps it may be objected, that, tho' Man's Body were suppos'd to be a Machine, yet it is so different from all other Machines, that it is impossible to discover all its Springs, partly, because they are so numerous, and partly, because some of 'em are so fine that they escape our view. But this objection will not be offer'd by any that are not afraid of taking pains. 'Tis true, 'tis a piece of difficulty to trace all the springs in the Body ; but that ought not to discourage us from advancing gradually, and coming as near to a just Idea of 'em as we can. Where our Corporeal Eyes fail us, our Reason ought to supply the defect, by imagining a structure conformable to what we know upon other heads.

The

The Author's Preface.

The first part of this Treatise presents you with an account of the Nutrition of the parts, the first preparation of the Aliment, the course of the Chyle, the alteration of that Liquor in the Heart, the various filtrations of the Blood, and in what manner it is qualified to nourish all the parts. The digestion of the Aliment is explain'd by a peculiar Hypothesis; and the motion of the Intestines is unfolded in a very different manner from any thing that has been yet publish'd upon that head.

My advances upon the Filtration of the Bile and some other Liquors are much of a piece with the common Sentiments; and bating the Explication of some Phenomena, there is nothing peculiar in the account I give of the nourishment of the parts.

In this third Edition, I have alter'd some few things, corrected some Errors that had crept into the former Impressions, given a new turn to some Explications, and added others. The whole is submitted to the Judgement of the Reader.

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The

THE
USES
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Man's Body.

CHAP. I.

Of the first Preparation of the Aliment.

THE First, or rather the most Important Function of the Body, is *Nutrition*. 'Tis the Basis and Foundation of all other Operations: The Blood and other Humors, the reparation and increase of the Organs, and the various internal and external Motions, do all depend upon it as their Source. Upon this account 'twill be proper to commence
B this

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this Treatise with a Description of the Organs imploy'd in that *Function*.

Before we swallow our Victuals, we cut, mince, and grind them, and mix 'em with Spittle. Then they pass through the *Æsophagus*, or Gullet, into the *Ventricle*; and being there converted into a Liquor call'd *Chyle*, are from thence convey'd to the Intestines; where the more refined part insinuates it self into the small Pipes, or Vessels, call'd the *Milky Veins*; and is by them convey'd to the Cistern of the *Chyle*, and the *Ductus Thoracicus*, in order to circulate along with the Blood.

On each Jaw-bone, we reckon four *Fore-teeth*, or *Incisores*, two *Eye-teeth*, or *Canini*, and eight *Grinders*, or *Molares*. The *Fore-teeth* are plac'd in the Front of the Mouth; the *Eye-teeth*, on the sides; and the *Grinders* towards the back part: By which Situation, the *Fore-teeth* are qualified to cut, the *Eye-teeth* to pierce, and the *Grinders* to grind the Food, and reduce it to smaller parts. The *Grinders* are split into several distant Roots; by which means the great impression, or shock, occasion'd by the grinding, is parcell'd out upon a greater part of the Jaw.

The Crocodile, the Pike, and other ravenous Animals, are only furnish'd with *Eye-teeth*; so that they can only pierce what they eat, and are oblig'd to swallow their Food, without mincing it: And accordingly we find entire Animals in their Bodies. That they can only pierce their Food, is apparent from the Juncture, or Articulation of their Jaw-bone, which admits of no motion from the right to the left, such as we meet with in Men, and other Animals; but only of that from above to below. Some other Animals, for instance, the Lion, the wild Boar, &c. are furnish'd with long sharp *Fore-teeth*, crooked *Eye-teeth*,

teeth, and Grinders of an uneven Surface. 'Tis advanc'd by some, that the Grinders of Lions are cut out, like a *Flower de luce* ; but the Comparison is very lame.

In the Squirrel, Rat, and other Animals, that snatch with their *Fore-teeth* ; the Teeth seem to be very small ; for they do not rise above a Line or two above the Gums : But at the same time, they sink very deep into the Jaw, arch-wise, which enables them to pull and snatch, without the danger of being disengag'd from the Bone. The reason of which is very plain.

The Animals which eat only Grass or Herbs, whether green or dry, and chew the Cud, are only furnish'd with pretty smooth *Cutters*, and some *Grinders*. Perhaps the roughness of their Tongue, Palate, and Gullet, contributes in some measure towards the grinding of the Aliment. Their *Cutters* are more serviceable for breaking and pulling, than for cutting. They are only plac'd on the lower Jaw, opposite to a pretty soft Eminence on the upper side ; by which means they are more capable to lock up the Grass, than if they were plac'd on both the Gums : For at that rate, several Sprigs would escape in the Intervals between the Teeth, and sometimes in the Intervals between their rougher parts. 'Tis manifest, that an Animal capable thus to hold the Grass between its Jaws, may easily break it with a motion of its Head. 'Tis observ'd indeed, that Grass-eating Animals move their Head from right to left, or from before backwards ; but never up and down : Which gives 'em less trouble, and enables 'em to pluck up the Grass with less force : For in the first place, they are not oblig'd to lift up their Heads, which being heavy, would require more force ; and in the next place, the very weight of their Head is employ'd in breaking the Grass.

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The Tongue, and some of the Muscles of the Cheeks, push forwards the Food, sometimes under the *Cutters*, and sometimes under the *Grinders*; but above all, when they are chew'd, the Tongue presses them forwards to the Gullet.

In the mean time, while the Food is a mincing and grinding, 'tis exactly mix'd with the *Saliva*: Which is a Liquor separated from the Blood in the Salivary Glandules, where the Sieve is so fine, or the Pores and Holes are so small, that the other parts of the Blood cannot pass. The Liver is furnish'd with a Sieve, by which the *Bile* is separated from the other parts of the Blood; the Reins, with another, for the Secretion of *Urine*; and these Glands, with a third, for the Secretion of the *Saliva*, which comes from the Blood, as the Blood does from Chyle, and Chyle from the Aliment. So that the difference of Food diversifies the Spittle: That of a Horse is entituled to different Qualities from those of a Man's; and upon the eating of Fish, the *Saliva* is different from that which follows the eating of Meat.

The *Saliva* is the first Dissolver of the Food; being qualified and necessary for that end. 'Tis probable, that the *Saliva* made of meager Food, is not proper for dissolving fat Food; and that which comes from fat Aliment, is not proper for lean Food. The difference being manifest in Persons of a nice tender Temperament, who are disorder'd by the change of Diet. This Conjecture is confirm'd by a common Experiment, *viz.* that all Rosins will only dissolve in Brandy, or some Sulphurous Menstruum; and Gums only in Water, &c. By reason that the parts of the Dissolver must be in a Capacity of insinuating themselves among the parts of the Body that is to be dissolv'd.

From

From which we may make an Inference ; that in order to a long Life, one ought always to feed on the same sort of Food, since the Concoction or Digestion is promoted by that means: For the Salivary Juice that comes from Bread, for instance, is more capable to dissolve Bread, than other Food, by reason of the conformity of their parts.

There is a prodigious number of Salivary Glandules ; most of which have been discover'd within these forty Years.

But before I proceed further, 'twill be proper to premise, that there are two sorts of Glandules in the Body. Some have an excretory Pipe, which carries its Liquor out of the Bounds for Circulation ; and are call'd, *Conglomerate Glandules*. Others again, have Pipes which convey their Liquor into the Passages for the Chyle, or Blood ; and are term'd, *Conglobate Glandules*.

There are two Glandules, situated behind and below the Ear, one on each side. *Steno* calls them, *Parotides Conglomeratae* ; and so joyns 'em to the first Rank of Glandules. They lie under the *Masseter*, and *Crotaphytes*, Muscles ; and are furnish'd with a Pipe, which terminates on the edge of the upper Lip, by the Fore-teeth, and has its Extremity surrounded with some Strings of Nerves.

There are two others call'd, the lower *Maxillares*. *Wharton* discover'd their Duct, which throws the Saliva into the Mouth. They are plac'd between the fleshy parts of the *Digastrick* Muscle ; and each of 'em has a Pipe, or Duct form'd out of several Branches, united in one common Orifice. One of the principal Branches of this Duct, embraces the *Digastrick* Muscle, before it joyns in with the rest : And afterwards they all terminate in one Mouth under the

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Tongue, having first receiv'd a Branch from the *Glandules* under the Tongue, call'd *Sublinguales*. To all these passages we must add the *Nose duct*, which throws into the Mouth a Liquor that is sometimes voided by way of Tears, when this Pipe is squeez'd or stop'd, or when the *Lachrymal*, or *Crying Glandules*, throw out too much Liquor.

The inner Coat of the Mouth, is cover'd with an infinity of little *Glandules*; from which a Liquor is squeezed forth by chewing. When the Jaw-bone is drawn downwards, the *Digastrick* Muscle swells, and squeezes the *Maxillar Glands* with their *Duct*, and so obliges them to throw out the Liquor. On the other hand, when the Jaw moves upwards, the *Masseter*, and *Temporal* Muscles, and those of the Face, swell and press the *Parotides Conglomeratae*; and by the same sort of Mechanism oblige 'em to void the Liquor they contain. In the action of chewing, the Muscle call'd *Buccinator*, serves likewise to wring the *Glandules* of the inner *Tunicle* of the Mouth, and express the contain'd Liquor.

Besides these, there are two hollow *Glandules* seated on the sides of the *Uvula*; each of which throws a Viscous Matter into the Mouth, by its peculiar Orifice. They're call'd, *Amygdala*, or *Almonds*.

Had M. *Descartes* taken Notice of all these Springs of Saliva, he had drop'd his Notion, that it sprung from Vapours arising from, and condensated upon the Palate: Especially if he had observ'd, that the upper Orifice of the Stomach is always shut close by a *Sphincter*. Now a *Sphincter* is a fleshy or musculous Ring, that serves to shut the Orifices of the Vessels, round which 'tis plac'd.

As for the Nature of the *Saliva*, 'tis doubted whether it is an Acid, or a Sulphureous Dissolver. But if we consider that it springs from the Aliment; that it mixes with Mercury; that it is of the same nature with *Water*, tho' a little more viscus; that it takes its rise from Acid, Salt, Sulphureous, and Alcaline Food; we will find no reason to doubt, but that 'tis an universal Menstruum, or Dissolver for all sorts of Food. Accordingly we find, it fixes Mercury like an Acid, it dissolves Sulphurs like an Alkali, it intangles like Sulphur, it dissolves Salts like Water, and it raises a Fermentation as spirituous and saline Bodies are wont to do. But after all, it seems to possess more of an occult Sharpness, and a volatile Salt, than of any other Quality.

Some have alledg'd, that it is only an Acid, unperceivable by the Taste. 1. Say they: It fixes Mercury like an Acid. 2. When 'tis mix'd with Dough, it makes it ferment. 3. 'Tis Corrosive; witness the Copper Basons made use of by Pocky and Scorbutick Persons. 4. Being poured upon an Iron-shovel red hot, it leaves a Mark upon it, which simple Water does not. 5. Being mix'd with the Solution of *Turnsel*, it turns it red; which might serve for a distinguishing Mark of an occult, or insensible Acid. 6. The Tetter and the Scab, are cur'd by rubbing the part with fasting Spittle: Which it could not do, if it were not acid. 7. It takes Stains, or Spots off Cloaths. 8. 'Tis viscus.

In answer to all these Difficulties, let's consider, 1. There are some things that are not acid, for instance, *Turpentine*, which fix Mercury; and 'tis very probable, that their Viscosity entitles 'em to their fixing Quality. 2. Its fermenting of Paste, does not conclude an Acidity;

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for some spirituous things, that are not at all acid, will raise such a fermentation; and we meet with an infinity of things, that appear in an opposite state to Acids, and at the same time ferment together, by reason of the diversity of their parts. 3. 'Tis true, that in some Diseases, such as the Pox and Scurvy, the *Saliva* will become quite acid, and even corrosive; but in its natural state, 'tis temper'd with other Qualities. 4. We do not give it in, as being of the same nature with pure Water. 'Tis well known, that 'tis laden with Salts: But we deny that those Salts are altogether acid. 5. 'Tis true, that if you mix it with the Solution of *Turnsel*, it imparts to it a red colour. But, at the same time, 'tis equally true, that it whitens the Solution of the corrosive *Sublimatum*, when mix'd with it. Now, as the one speaks Acidity, so the other vouches for its Volatile Alkaline Qualities; so that 'tis not simply acid. 6. There are a great many strong Alkali's, for instance, the *Oyl of Tartar*, which cure the Tetter: So that the *Saliva's* Virtue on that score, is no Evidence for its acidity. 7. Several Lixivious Salts will take Spots and Stains off Cloaths. 8. *Turpentine* is viscous, notwithstanding its want of acidity. 'Tis true, Acids do sometimes fix Liquors, but they do not always render 'em viscous; nay, on the contrary, they sometimes remove their Viscidity. So that we have reason to conclude, that the *Saliva* is an universal Dissolver of all sorts of Aliment, whether Sulphureous, Alkaline, Acid, Saline, Watery, Earthy, Spirituous, or Gummy; because it is the Product of all these. And if it happens sometimes, that too large a quantity of Sulphureous, or Acid Food, occasions Crudities and Indigestion; 'tis owing to this, that this Menstruum had not a sufficient stock of such parts as were proper to dissolve 'em. 'Tis

'Tis very conducive to Health to chew long ; because, 1. By that means the Food is better minc'd and grinded. And, 2. 'Tis more impregnated with Spittle ; for the greater motion of the Muscles, squeezes out more, and at the same time it joyns in more closely with the smaller parts of the Aliment, when thus attenuated.

The Food being impregnated with the *Saliva*, is push'd by the Tongue into the *Pharynx*, or Head of the Gullet. In the mean time, the Head of the *Wind-pipe* is exactly cover'd, and shut with the *Epiglottis*, which hinders the Meat and Drink from falling into the Wind pipe, in its passage over it to the Gullet : And if by chance the least Crumb of Victuals, or the least Drop of Drink, falls into the Wind-pipe, it raises a Cough, that commonly does not cease, 'till it be forc'd out of the Pipe.

The *Pharynx* is furnish'd with several Muscles. The *First* is fastened by one end to a Process call'd *Styloides*, and by the other to the side of the *Pharynx*. The *Second* has one end fasten'd between the first *Vertebra* of the Neck and the Head, and the other on the side of the *Pharynx*. The *Third* is fasten'd at one end to the sharp Eminence, or Point of the *Sphenoides*-Bone, and at the other, to the lower part of the *Pharynx*. The *Fourth* is a Ring of fleshy Fibres, encompassing the *Pharynx*, and part of the *Gullet*.

Stilo-Pharyngæum.

Cælo-Pharyngæum.

Spheno-Pharyngæum.

Oesophagiæum.

When the first three of these Muscles act jointly, they shorten themselves, and by consequence raise and open the *Pharynx*, which gives the Tongue an opportunity of thrusting down the Food

Food with less force. After which the fourth Muscle swells, and gradually straitens the Gullet, by which means the Meat slides by degrees into the Stomach.

The inner Membrane of the Gullet, is strew'd with an infinity of little Glandules, which furnish a Liquor (especially when they are press'd by the Victuals) that contributes to make 'em glide along the Gullet, and is also of use to dissolve 'em, when lodg'd in the Stomach.

The Arch of the Palate is likewise worth our Consideration: 'Tis form'd in an exact Proportion to the Figure of the Tongue; by which means the Meat being chew'd does readily yield to the pression it meets with at the end of the Arch. Before the Victuals enter the *Pharynx*, they salute the *Uvula*, and a sort of little soft Skin that keeps it up; and by Virtue of their pressure upon all these parts, the Passages leading from the Mouth to the Nose, are exactly shut; but when the Victuals are thrown back, this little Skin, and the *Uvula*, endeavouring to oppose their return, give an easie entrance from the Mouth into the Nostrils: And accordingly, when one Coughs vehemently, or Vomits, part of the Matter passes through the Nostrils. And upon the same account, says *Salmuth*, a Child brought into the World without the *Uvula*, or *Almonds*, threw the Milk out at the Nostrils, and died in a little time. But after all, several Persons who have had the whole *Uvula* cut off, have been free from that Inconveniency; by reason that the Skin which keeps up the *Uvula*, and the *Almonds*, is sufficient to put by the Victuals from entering the Passage which leads to the Nostrils.

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Tab. I.

Pag. II.

Fig: 1.



Fig: 2.



T A B. I.

*Representing the Lymphatick and Salivary Vessels
in two Horses Heads.*

Fig. 1. Taken from Steno.

- a a. *The Conglomerate Parotides.*
- b b. *The Roots of the external Salival Duets.*
- c c. *The Conglobate Parotides.*
- e e. *The Trunk of the external Salival Pipe.*
- f f. *Some Branches of the Jugular Duets.*
- g g. *Some Lymphatick Vessels.*

Fig. 2. Taken from Wharton.

- a a. *The lower Maxillar Glandule.*
- b b. *The Roots of the Salival Pipe.*
- c c. *The Digastrick Muscle.*
- d d. *The Branch of the Salival Duēt, that embraces the Digastrick.*
- e. *The common Trunk of the Salival Duēt, terminating by the Fore-teeth of the lower Jaw.*

C H A P. II.

Of the Alteration of Food into Chyle.

THE Changes that happen in our Bodies, are very surprizing ; and the surprisal would be still greater, if they did not come to pass by degrees. Before the Meat we eat is transform'd into Bones, Flesh, Cartilages, Membranes, &c. it must first undergo divers Preparations, and Alterations. Accordingly, 'tis first of all transform'd into Chyle, after that into Blood, &c. But in order to a compleat Knowledge of the manner in which the Aliment is turn'd into Chyle, 'twill be necessary to survey the Fabrick of the Parts employ'd on that occasion.

There is a pretty large passage, reaching from the Mouth to the Fundament, which we call the *Intestinal Passage*. This meets with various Names, according to the variety of its Situation and Figure. From the Head of the Gullet, to the Diaphragm, 'tis call'd *Oesophagus*. After it pierces the Middriff, it grows larger, and forms the *Ventricle*, or *Stomach*, which is like a Bag, through which all that we swallow passes. Afterwards it grows smaller, and forms those Pipes commonly call'd the *Intestines*, or *Guts*.

This large Duct is compos'd of three Membranes. The inner one is glandulous ; the second fleshy, or muscular ; the third strong and tendinous.

The inner Coat is very sensible, where 'tis not glandulous ; and this its tender Sense, raises in us the Sense of Hunger and Thirst. 'Tis cover'd
with

with a slimy Humor, that prevents its being hurt by the Fermentation of the Food, or gall'd by the sharp Juices that pass that way. In the Gullet 'tis smooth, and all of a piece; in the Stomach 'tis somewhat rough and uneven; but in the small Guts, and the Gut *Colon*, it furls up in the form of Membranous Circles; and the Intervals between these are call'd *Little Cells*. In the small Guts, this Coat is deck'd with small Hairs.

The Structure of the *fleshy Coat* is diversified according to the variety of its Situation, as well as that of the *Glandulous*. Along the Gullet it has two Rows of Fibres, one running straight along, and another of Circular Fibres. Some will have these Circular Fibres to be Spiral; and indeed 'tis not easie to decide the Question: But let it be as it will, 'tis of no great Importance. In some Animals, the Gullet has two Rows of Fibres, which run Spiral-ways, and cross one another where they meet, in a very singular manner; for that Row which was upper-most at the first crossing, becomes lower-most in the next; so that one and the same Row, is sometimes the upper one, and sometimes the lower. Dr. *Willis* alledges, that one of these Rows ascends, and the other descends; and that the descending one assists in Swallowing, and the ascending in Vomiting. But since both of 'em do equally ascend and descend, and have the same Figure and Bandage, we have no reason to assign 'em different Uses.

The fleshy Coat of the Intestinal Passage, is furnish'd with several Rows of Fibres, one above another, in order to compass the different Motions 'tis observ'd to perform. In the Stomach it has some running length-ways, some circular, and some oblique. The Action of these Fibres consists

sists in shortning themselves, and contracting the Stomach.

In the Intestines the fleshy Coat has only two Rows of Fibres ; one outer Row running length-ways, and an inner one of circular Fibres, which seem to have the Mesentery for a Tendon, without any Resting-place.

The outer Coat is uniform all over the Intestinal Passage. 'Tis strong and tendonous, and hems in the rest, to prevent their over-dilating themselves.

The little Glandules ty'd to the inner Membrane, are seated between it and the fleshy Membrane. Each of these Glandules sends out an excretory Pipe, which penetrates the glandulous Membrane, and empties the Liquor separated in the Gland, into the Cavity of the Intestinal Duct.

The Glandules in this Passage, are of several sorts. Those sticking in the inner Coat of the Stomach, are so very numerous, that some Anatomists have affirm'd it, to be only one enlarg'd Glandule. The small Intestines present us with an infinite number of Glandules, drawn up in Bundles, each Bundle having an excretory Pipe. But in the great Intestines, there are several other little Glands, call'd, from their Figure, *Miliar Glandules*, because they resemble Millet-Seeds ; and each of these has its excretory Pipe, which empties it self in the Gut.

The Vessels detach'd to the Glandules, or Membranes of the Intestinal Passage, are deriv'd from several Trunks.

The Nerves of the *Oesophagus* rise out of the eight Pair : Its Arteries take rise from the *Carotides*, and the Intercostal Arteries. Its Veins terminate in the Jugular Veins, and that call'd *Azygos*.

The

The Stomach has two large Strings of *Nerves*, which we call *Stomachical* : They're deriv'd from the eight Pair. One of these *Nerves* is particularly detach'd to the inner parts of the Stomach, and the other to the outer parts. The Arteries that resist these parts, take their rise from the *Coeliack* Artery ; and all their Branches have *Anastomoses*, or Communications one with another : So that tho' some of 'em were stop'd up, the rest would convey the Blood to all the parts of the Stomach. Its Veins are contriv'd after the same manner ; so that one Branch will convey the Blood, when the other is shut. All of 'em end in the *Vena Porta*.

As for the *Veins* and *Arteries* of the Intestines, almost all of 'em spring from the *Mesenterick Vessels*. All the Arteries spring from the *Mesaraick Arteries*, bating the *Intestinal*, and *Hæmorrhoidal*, which take their rise pretty often from the *Coeliack*. The Veins of the Intestines empty themselves either in the Mesentery, where they're call'd *Mesaraick*, or else in the *Splenick* Branch, as the internal *Hæmorrhoidal* Vein often does : For the external joyns the *Hypogastrick*, and the *Vena Cava*. The other Vessels retaining to the Intestines, shall be treated elsewhere. Their Nerves are deriv'd from the *Par vagum*.

There is a remarkable Knot of fleshy Fibres, upon each end of the *Oesophagus* ; or at least the fleshy Membrane is much stronger towards the ends of the Gullet, and forms it self into a *Sphincter*, in each of these places.

The Gullet having pass'd the second Muscle of the Middriff, enlarges it self to the left side, and forms the upper Orifice of the Stomach, call'd *Cardia*. The lower Orifice call'd *Pylorus*, lies on the right side, as high as the upper Orifice, in a Man, when he stands upright. The Ven-

16 T A U V R Y'S ANATOMY.

Ventricle lies between these two Orifices, in the form of a Bagpipe, being seated under the Diaphragm, between the Liver and the Spleen.

At the end of the *Pylorus*, there's a *Valve*, that gives the Aliment admission into the Guts, but hinders their return from the Guts into the Stomach. After you pass the *Pylorus*, the remaining part of the *Intestinal Passage*, is call'd the *Intestines*. Some of which are *small*, and some *great*. There are three *small* Intestines, *viz.* the *Duodenum*, *Jejunum*, and *Ileon*; and likewise three *great* ones, *viz.* the *Cecum*, the *Colon*, and the *Intestinum Rectum*, or the straight Gut.

The *Duodenum* is continuous with the *Pylorus*.

By Inches
is meant the
breadth of
the Persons
own Thumb.

Some Anatomists affirm, that 'tis so far from being Twelve Inches long, that it has scarce four. But the Dispute is only nominal; for if we measure from the *Pylorus* to the end of the winding of the *Jejunum*, we'll find it twelve Inches. This Gut is fasten'd to the Vertebrae of the Loins, by some membranous Ligaments. It receives the *Pancreatick* Duct, and that of the Bile call'd *Cholidochus*, about the place where it begins to wind; which those who allow it only four Inches in length, take to be the beginning of the *Jejunum*.

The *Jejunum*, and *Ileon*, lie together, like a large Bundle, in the Region of the Navel; the head of which is less stuff'd than the end; both by reason of the irritation and motion of the neighbouring Bile, and their advantageous Situation in a place, where the *Muscles* of the *Abdomen* make more vigorous Efforts in pushing the Food into the lower Intestines.

At the end of the *Ileon*, the Gut enlarges it self, and is call'd *Colon*. At the Head of this, the Gut forms a sort of Bag, and is call'd *Coe-*

cum.

cum. Here we observe a long hollow Appendage, which perhaps may serve for a Ligament.

In the beginning of the *Colum*, we meet with a Valve, which favours the descent of the Excrements, but opposes their return. Tho' this membranous Valve is nothing else, but a Fold of the inner Membrane; yet, 'tis false, that it disappears after the breaking of the Ligaments of the *Colum*. This Gut begins near the right Kidney, where the Appendage I mention'd but now is fasten'd. Then it surrounds all the small Guts, and in its circular Course touches the Liver, the Gall-bladder, the bottom of the Stomach, the Spleen, and the left Kidney: And after that, having finish'd its Circuit, comes to an end.

Some Authors have allotted it an infinite number of Ligaments. But we meet only with one, which runs from the *Coecum* to the *Rectum*; and by furling the Intestine, forms those Wrinkles and Cells observable in it. This Gut is likewise fasten'd to the *Peritonæum*, and the Caul.

When the Gut arrives at the *Os Sacrum*, 'tis call'd *Rectum*, and runs straight down to the Fundament. Here 'tis incompartis'd with the *Hæmorrhoidal* Veins and Arteries, as with a Garland: As also with a great Bundle of circular fleshy Fibres, which make the *Sphincter* of the *Anus*. This *Sphincter* is a Muscle fasten'd to the lower part of the *Os Sacrum*. This Gut has likewise two other Muscles, call'd from their use *Levatores*; which rise from the Bone call'd *Coccyx*, and are inserted into the Fibres of the *Sphincter* Muscle.

The *Sphincter* by bloating it self up, and becoming shorter, shuts the extremity of the *Rectum*; and the two other Muscles, by swelling and growing shorter, raise it up, and keep it in its ordinary posture.

Now, the use of all these Parts, will be best understood, by calling to mind our former Advances upon the Head of *Chewing*. The Aliment being chew'd, and thrust down the Throat, provokes the fleshy or muscular Coat of the Gullet, to swell and contract it self successively; by which reciprocal Motion the Meat is forwarded to the Stomach; it being first chewed to facilitate its passage. But Mastication facilitates not only the Swallowing, but even the Concoction of the Victuals; for when they are ground, they present a larger Surface to the Liquor that is to dissolve 'em; just as a Plaister, that being broke in small pieces, is more easily penetrated by Water.

Such Animals as are not furnish'd with Teeth on both their Jaws, have, for the most part, several Ventricles. Those which chew the Cud have four; the first of which is much larger than the rest, and has no communication with 'em; being seated on the left side, whereas the other three are plac'd on the right side. When the Animal has fill'd this first Ventricle, which we commonly call the *Paunch*; the fermentation of the Grass, or Hay, obliges its fleshy Coat to contract it self. This occasions the throwing back some small parcels, which the Animal chews and grinds over again, upon the rough Surface of its Throat. Then it swallows 'em again, but they do not return into the *Paunch*, but are convey'd to the second Ventricle. From thence they pass to the third, which, by reason of its Leaves, is call'd, the *Book*; where the Food is press'd and squeez'd together. This Ventricle has a small Pipe, answerable to our Gullet, by which almost all the Drink is convey'd into it; for there runs but very little into the former two. At last the Food passes from this Ventricle, into a fourth, which
per-

performs the Office of ours. Its inmost Coat has a great many Folds, which qualifie it for containing more Glandules.

'Twould be worth one's while, to produce a Reason, why these Animals first convey their Food into the *Paunch*; why their chewing the Cud seems to be voluntary; why the Food chew'd a second time is transmitt'd to the second Ventricle; and why all the Drink pass'd directly into the third, without visiting the first or second Ventricle. But such an attempt would lead us out of our way.

The greatest part of *Fowl* have two Ventricles, one of which has very strong Muscles, and deep Chinks, in which the little Stones swallow'd by those Animals are lodg'd; by which means their Food is as well ground as with Teeth.

The *Saliva* is not the only Dissolver of the Food; for the Glandules of the innermost Coat of the Ventricle furnish a Liquor which performs part of the dissolution.

'Tis question'd, whether this Liquor is a pure Acid, or not. Those who take up with the Affirmative, alledge, 1. That if you open the Bill of any Fowl after eating, you'll smell a Sourness.

Vanhelmont's
Reasons.

2. If they were not possess'd of a strong Acid, they could not digest Stones, as 'tis known they do. 3. In dissecting a living Animal, after Digestion, we meet with a sour Steam.

4. Acids promote Digestion. 5. After eating tablets of steel, the Steams that arise resemble those occasion'd by pouring an Acid upon any Preparation of Steel. 6. The curdled Milk, found in the Ventricles of Calves, is acid. 7. The Ostrich which swallows Copper, turns it green. 8. If one drinks Milk fasting, and vomits it up again, it presently curdles.

Tachenius's
Reason.

In answer to these Reasons, I propose the following Remarks. 1. We do not deny, but that this Liquor contains some acid Salts ; but we alledge, these are temper'd with other Principles. 2. The Acid never has the ascendant in that Liquor, but when the Animal is in disorder. Upon this supposition 'twill be easie to explain how the four Steams come to be met with in a Fowl's Bill ; how a sharp Steam comes to rise in the Dissection of Dogs ; and how 'tis that Men themselves have somewhat that resembles it. For, 1. This never happens, but when the Animal is sick, and the Principles of the Ferment of the Stomach are over-agitated, or after the eating of too great a quantity of such Food as is apt to turn sour. 2. When a Fowl swallows Stones, he throws 'em out again without any alteration ; for they serve only to promote Digestion, by filling the Chinks of the Gizzard ; so that when the Muscles of that part are in action, they may easily grind the Grain upon which the Animal feeds. And if, at any time, these Stones become more polish'd and smooth, 'tis owing to their rubbing to and again, and not to the acidity of the Liquor in the Stomach. 3. Tho' Acids promote Digestion, yet 'tis not always so. And when they do it, 'tis by causing a Motion in the Stomach, which strains forth a greater quantity of the dissolving Liquor. 4. Several things that are not acid, give the same smell as Acids do, when mix'd with *Steel*. 5. The curdled Milk in Calfs contains a sour Juice, because it has received some Acids which have curdled it ; just as Milk put into a hot place, or expos'd to the Air where Acids are, turns sour. In fine, if Copper turns green in the Stomach of an *Ostrich*, 'tis less owing to the Acidity, than to the sharpness of the Humors joyn'd to the rubbing ; and if it dissolves,

'tis

'tis more owing to the rubbing against the little Stones in the Fowl's Stomach, than to the Liquors. In order to know, whether the dissolution of Copper, or Silver, was occasion'd by rubbing against the Stones in the Stomachs of Fowls, or by the force of the dissolving Liquor; an Experiment was made, by making an *Indian* Hen swallow Pieces of Silver Money roll'd up; and 'twas observ'd, that the Characters within were not at all defac'd, but only those on the outside; which was certainly occasion'd by the rubbing. M. *Peraut* try'd a fresh Experiment, by making an *Ostrich* swallow a piece of emboss'd Copper; and having afterwards dissected the *Ostrich*, he found that the Characters on the hollow sides were entire, but those on the lower side were defac'd and batter'd.

When the Aliment is convey'd into the Stomach, the Salival and Stomachical Juices insinuate themselves by degrees into it. But they would require too long a time for insinuating themselves, if the hot and active Spirits coming from the Liver and Spleen, and even from the Fibres of the Stomach, did not agitate the matter with a great deal of force, so as to make it penetrable by those Liquors. While these Spirits shake and toss the Aliment, it swells and heaves up, and enlarges the extent of the Stomach; which by virtue of its enlarged Dimensions, presses upon the Gall-bladder, and the Sweetbread, they being seated in its Neighbourhood. This pressure makes the Gall-bladder, and the Sweetbread, to empty the Bile, and Pancreatick Juice, into the *Duodenum*; and at the same time the swell'n Substance lying close to the Walls of the Coats of the Stomach, shuts their Pores, and prevents the wonted dissipation of the Spirits within the Stomach. Now the dissipation being

prevented, and fresh Spirits still arriving, the Fermentation must needs oblige the Fibres of the Membranes to swell and shorten themselves ; by which means the Cavity of the Stomach is less'n'd. And this Stricture of the Stomach join'd to the Shocks of the Diaphragm, forces out the fermented Matter. Now it cannot make its exit by the Gullet, by reason of its Sphincter, which, over and above its natural strength, is closely shut down by the pressure of the Diaphragm upon the Stomach : So that it must make its way by the *Pylorus*, that being the place where it meets with least opposition. Pursuant to this Doctrine, Vomiting never happens, but when the Sphincter of the *Pylorus* is more violently contracted than that of the Gullet.

When part of the Aliment is discharg'd, the active Parts of the Blood and Spirits, having room to insinuate themselves into the Cavity of the Stomach, cease to swell up the Fibres so much as before ; and falling in with the remaining Matter, tols and ferment it more than it was before. Upon which it heaves up, and stops the Pores of the inner Coat afresh ; and the Spirits finding no place to get out, swell up the Fibres, and so occasion a new Contraction of the Stomach, which forces the *Chyle* into the *Duodenum*. But when there remains but very little of that Matter in the Stomach, 'tis incapable to heave up to an equal height with the former, and for that reason continues in the Stomach, and after a long agitation and fermentation, rais'd by the Spirits and Salival Juice, becomes sharp ; and by twitching the Walls of the Stomach, and shaking the Nerves, raises in us a Sense of Hunger : And when the Salival Juice is scanty, and the Fibres of the Stomach, for want of due moisture, become dry and stiff, and less pliable and unfit
for

for their wonted Motions, we are then affected with a Sense of Thirst. This remainder of Chyle being extremely wrought and fermented, is serviceable in the dissolution of fresh Meat, by virtue of the Spirits it contains; as a Remnant of Dough will serve to ferment a fresh Mass.

The Chyle being lodg'd in the *Duodenum* mixes with the Choler and Pancreatick Juice; which were squeez'd out of their respective Vessels, by the pressure of the Stomach, when distended by the fermenting Food, and urg'd by the Shocks of the Diaphragm. These two Liquors render the Chyle more fluid; and the Bile dissolves the *Mucous* of the Intestines; so that upon the least Stricture of the Intestines, the refined part of the Chyle will enter the *Milky Vessels*. Now this Stricture is perform'd by the Hethy Fibres, and the repeated pressure of the *Diaphragm*, and the Muscles of the *Abdomen*. But, after all, if the Intestines had not their Turnings and Windings, and were not furnish'd with Folds and Cells, all that pressure would only push the Matter downwards, but would never make any part of it to enter the *Milky Vessels*.

The rest of the Chyle being impure, and of too coarse parts to enter these Vessels, is convey'd to the great Intestines. This Excrement passes through the *Cecum*, and all the Turnings of the *Colum*, and in its passage imparts a gentle heat to the bottom of the Ventricle. Its descent is promoted in the *Colum* by the provocation the Fibres of that Gut receive from the Bile, which taints them where they touch the Gall bladder.

'Tis remarkable that the *Cecum*, which is so very small in Men, is very large in some Animals. The *Ostrich* has two of 'em. in a spiral form; and most Fowls have two very large ones; but then they have no *Colum*.

The *Rectum* has nothing peculiar, but its *Sphincter*; which is always shut, or has a tendency so to be, except when a greater force obliges it to open. Now this over-bearing force is the weight of the Excrements, and the impulse they've receiv'd from the Muscles of the *Abdomen*, and the *Diaphragm*, and the Motion of the Intestines. They display their superiour force, either by straitning the passages for the Spirits, and intercepting the Recruits, upon which the swelling of the Muscle must cease for some time; or by becoming very sharp; for then they ulcerate and unrip the Fibres of the *Sphincter*, which gives vent to the matter that should distend the Muscle, and unbends the Fibres. When this Muscle is seiz'd with a Palsie, or Cut, the Excrements are voided involuntarily.

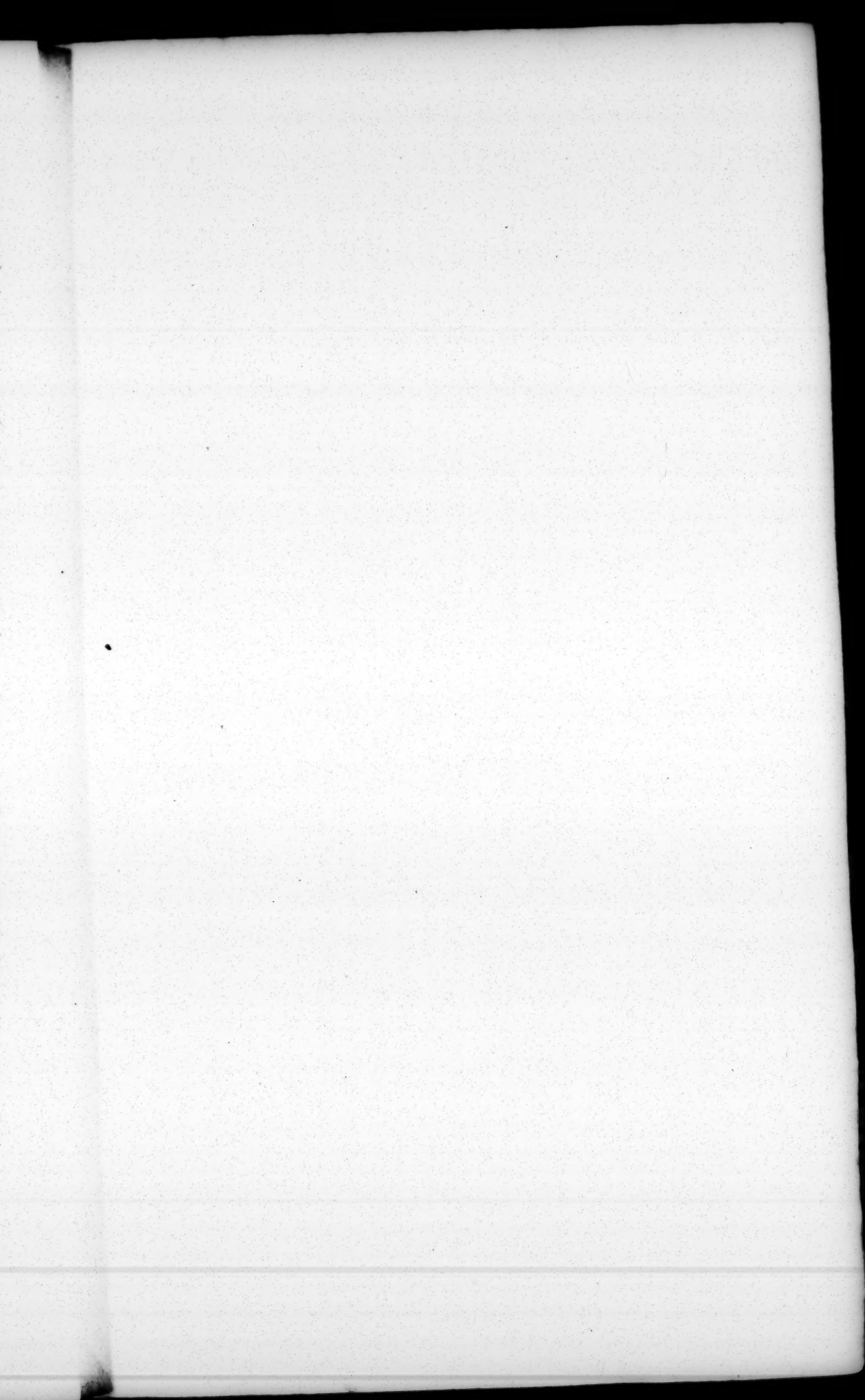
The circular fleshy Fibres plac'd all along the Intestines, perform the same Office, that the *Sphincter* does at the extremity of the *Rectum*. I mean, they are always shut, 'till some Matter comes to dilate them: For 'tis easily conceivable, that each circular fleshy Fibre contracting it self, must dilate that which is immediately under it; because it thrusts into it the dilating Matter: And in like manner, when this lower Fibre contracts it self, it pushes the Matter down to the next Fibre below it. And at the same time, 'tis easie to explain how it comes to pass, that a circular Fibre dilated by the excrementitious Matter, must needs contract it self; for when the Matter stops its Pores, the Spirits ranging in that Fibre cannot get out, so that of course they swell it up and shorten it. By consequence, the contracted Fibre squeezes the Matter, and drives it to the inferiour Fibres, which enlarge and contract themselves successively, by the same Rules, and for the same Reasons. This, I take it, is a more
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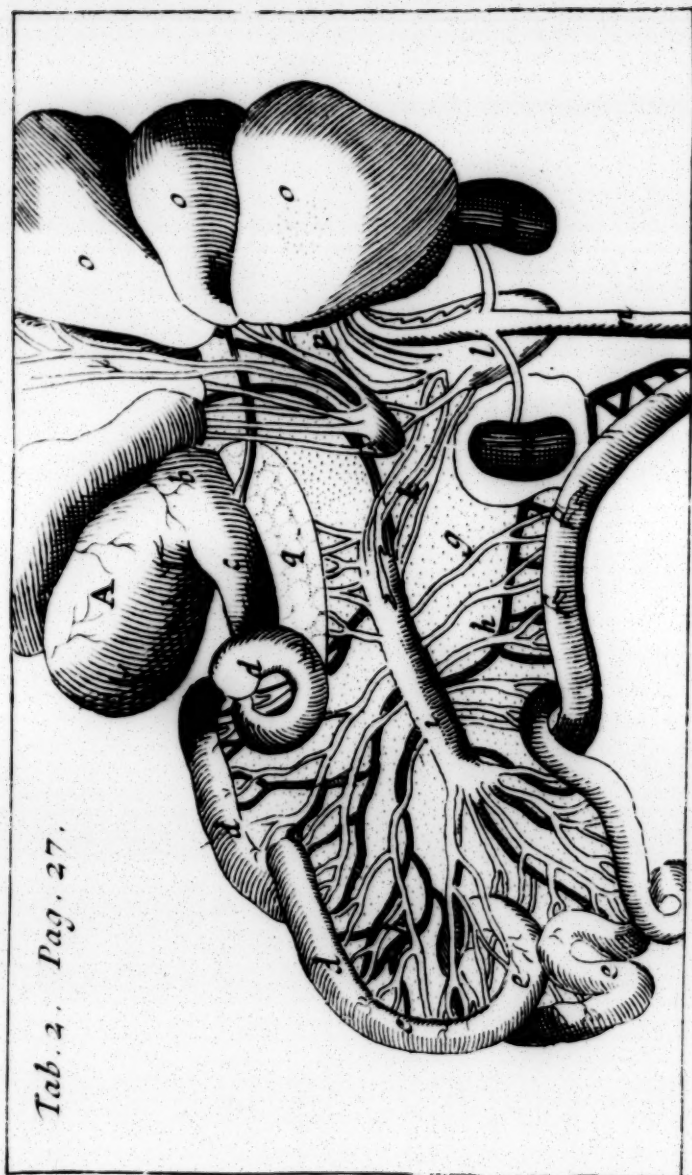
sensible way of explaining the *Peristaltick* Motion of the Intestines, than that of some Modern Writers, who suppose, that *Willis &c.* the Intestines have some Fibres on purpose for dilatation, and others for contraction; and that the one sort have their Tendons on the outer Membrane, and the others on the inner: Besides, I cannot conceive, how the Fibres of the Intestines should dilate 'em by swelling; for if they did, they must have their resting-place off from the Intestine; or else the Fibres that run length-ways must have their two ends fasten'd very strongly. and the Intestinal Pipe must be all in a straight Line.

I have now dispatch'd what I had to advance, for a natural Explication of the Generation of Chyle, and the first Preparation of the Aliment. It remains to illustrate the *Phænomenons* that depend upon that; particularly that of the Generation of Wind, which is the principal and most difficult. In order to adjust this matter, as I take it, the subtilest Particles of Food, and the Air swallow'd along with them, are the substance of the Wind; but the Noise that accompanies them, is neither the Product of the Air, nor of the subtile Particles of Food, unless they are inclos'd and cramp'd. If there's a great deal of Wind in the Stomach, and the lowermost Ring of the Gullet has not a force sufficient to withstand the shock, 'twill force its way. But that violence cannot be put in execution without a Collision, which occasions a little dumb Noise; and forasmuch as the upper end of the Gullet is guarded by another *Sphincter*, there will be a necessity of a second jostling. And this is the Reason that some Moderns give for the Noise that accompanies Belchings. But after all, we must add to this,

this, that the subtile parts of Food, have sometimes an acid taste, or that of Eggs brooded on ; which happens when the Stomach-Juice is deprav'd, or when one has eat such things as are apt to turn sour, or has eat too large a quantity of 'em. Wind hatch'd in the Stomach or Guts, does always take its rise from Air, and rarified Matter, which enlarges its dimensions : And as any viscous, glutinous, or clammy Substance, is apt to rarify, by reason of the bulk and figure of its parts, so 'tis very apt to create Wind. Accordingly we find, windy Cholicks are occasion'd by eating Pease, Beans, Navews, Chestnuts ; and in a word, all sorts of Victuals that consist of glutinous parts, and produce a great deal of Wind in their Fermentation. The Stench that attends 'em is owing to the coarse Sulphurs of such Victuals, the parts of which are put into a violent motion by the Fermentation. The Noise occasion'd by their exit, is owing to the Collision they are oblig'd to, in forcing the *Sphincter*.

All the advantage we can make of Wind, is, that when 'tis cramp'd and penn'd up between two Columns of Excrements, and endeavours to avoid the Shock, it forces down the interior Column, that being more movable than the upper ; and that for two Reasons : 1. Because the Intestines grow larger as they descend. And, 2. Because the small Intestines are furnish'd with a greater number of Valves than the great ones ; and even in the *Colon* the Valves are so plac'd, that they favour a descent, but oppose a return. So that without all doubt, the impulse of confin'd Air, forces the inferior Row of Excrements to give way.





Tab. 2. Pag. 27.

T A B. II.

Representing the Intrails of the Abdomen, in a Dog.

- A. *The Ventricle.*
- b. *The Pylorus, or entry from the Stomach into the Intestines.*
- c. *The Duodenum.*
- dd. *The Jejunum.*
- ee. *The Ileum.*
- f. *The Colon.*
- g. *The Mesentery.*
- h. *The first Milky Vessels rising out of the Intestines, and reaching to Asellius's Pancreas.*
- i. *The Pancreas, where they terminate in some Animals. In Men there's no such thing; but instead of that, several little Glandules scatter'd up and down the Mesentery.*
- K. *The Milky Vessels of the second Rank.*
- l. *The Receptacle of the Chyle, which receives the Secondary Milky Vessels, that spring from Asellius's Pancreas.*
- mm. *The Kidneys.*
- n. *The Vena Cava.*
- ooo. *The Lobes of the Liver.*
- p. *Some Lymphatick Vessels, running from the Liver to the Cistern of the Chyle.*
- q. *The Pancreas, or Sweetbread, seated under the Ventricle, and the Duodenum; in Men, as well as other Animals.*

C H A P. III.

Of the Course of the C H Y L E.

ITold you before, that the Intestinal Passage is ty'd to a pretty strong Skin, which we call the *Mesentery*; bating the *Duodenum*, *Colum*, and *Rectum*, where 'tis not at all, or almost not at all fasten'd. This Skin is the Product of the *Peritoneum*. 'Tis fasten'd pretty firmly to the first *Vertebra* of the Loyns; and has a very large circumference, to which the Intestines are ty'd, so that it keeps 'em in the same posture.

'Tis compos'd of two Membranes; between which we meet with Veins, Arteries, Nerves, Milky Vessels, Lymphatick Vessels, and Glandules.

The Arteries take rise from the superior and inferior *Mesenterick* Artery; the Veins are call'd the *Mesaraick* Veins, and empty themselves in the *Vena Porta*. The Nerves are deriv'd from the Eight Pair, and are gather'd into several *Plexus*.

The Lymphatick and Milky Vessels ought to be more narrowly survey'd; because they are not to be met with in any other part of the Body; or if we meet with any thing of that nature, it has something of a remarkable difference. Under the same Head, we shall treat of the Glandules of the *Mesentery*, since they entertain a close Correspondence with the former.

In Dogs, and some other Animals, the Center of the *Mesentery* presents us with a great Knot of Glandules, which are commonly call'd *Asellus's*

lius's Pancreas, *Asellius* being the first Discoverer. But in Men the Glandules are scatter'd all over the Mesentery.

During the time of Digestion, there are no Lymphatick Vessels to be seen in the *Mesentery*, but it discovers an infinity of Milky Vessels. And on the contrary, after Digestion, all the *Milky Veins* disappear, and a prodigious number of Lymphatick Vessels present 'emselves to our view. This gave occasion to a Conjecture, that the Lymphatick Vessels of the Mesentery are the same with the Milky Vessels; and carry sometimes pure Lymph, and sometimes Lymph mingled with Chyle. To back this Opinion, 'tis alledg'd, that if it were not so, the Milky Vessels could not be always open, and ready to receive the Chyle; because when they're empty, the walls or sides of the Pipes would unite and stick together.

The Lymphatick Vessels spring from the Glandules of the Intestines, which are as it were a passage, that conveys to them at once the Chyle and the Lymph. Some Anatomists have thought, that the Hairs of the inner Membrane of the Intestines, serve for Vessels to convey the Chyle into the *Milky Veins*. *De Vernay.*

But since that Advance is not back'd by either Reason or Experiment; and since we do not find that the Hairs of Animals are employ'd as Vessels to convey any thing into the Body, notwithstanding their being hollow; 'tis more probable, that these *Mesenterick Glandules* have Pipes that open into the Gut.

All the *Milky Veins* terminate in some Animals, in *Asellius's Pancreas*; and in Men, in the Glandules. The Chyle, in its passage through these Glands, mixes with a spirituous Lymph, that renders it more fluid and active. When the Chyle is too thick, these Glandules are shut, and
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the Chyle is voided along with the Excrements. This we call the *Coeliack Passion*. For we are not to believe with some modern Authors, that the Glandules which the Lymphatick and Milky Vessels visit in their course, serve only to purifie the Liquors that pass through 'em ; for there's no Vessel to receive and carry off the Impurities.

The Chyle having stopp'd for some time in these Glandules, runs into the *Secondary Milky Vessels*. These Vessels are not so numerous, but they're larger than the *First*. They empty themselves in the *Cistern of the Chyle*, or *Pequet's Receptaculum*, so call'd from its first Discoverer. This Cistern lies between the *Vena Cava*, and the *Emulgent Vein*. In Brutes, 'tis membranous : But in Men, there are only two Glandules, call'd *Lumbares*, seated between the Kidneys, and the *Capsula atribiliaria*, between the *Coeliack* and *Emulgent Vessels*. These Glands send forth two Branches, which uniting together make the *Ductus Thoracicus*, or *Chyle-Passage* in the Breast ; which ascends all along the *Aorta*, between the *Ribs* and the *Pleura*, and disburdens it self in the *Subclavian Veins*, near to the *Axillary Veins*.

These Vessels have Suckers or Valves, which favour the Course of the Chyle towards the *Subclavian Veins*, but oppose its return ; being plac'd looking from without inwards. These Valves are visible, especially in the *Ductus Thoracicus* ; and also in the other Lymphæducts, especially when their Liquor is stopp'd or congeal'd.

'Tis by virtue of this Disposition of the Valves, that the smallest Contraction of the Intestines pushes the Chyle into the *Vena Lactæ* ; and the Chyle being hindred to return, is oblig'd to rise up to the *Cistern*. This Cistern is straiten'd and press'd, when the Middriff descends in respiration ; by which

which means the Chyle being dislodg'd, and not being able to make good its descent in opposition to the Valves, 'tis oblig'd to ascend to the *Ductus Thoracicus*.

This *Duct* in the Breast is likewise press'd and squeez'd by the Shocks of the *Aorta*; and in the mean time the Chyle being continually push'd forward by that from the Cistern; is forc'd to run up to the *Subclavian Vein*.

At the Head of the *Thoracick Duct*, as it enters the *Subclavian Vein*, there stands a *Valve*, which hinders the Blood to enter the *Duct*, but gives free passage for the Chyle into the Vein.

Sometimes we meet with two *Thoracick Ducts*, which unite before they open into the left *Axillary Vein*; nay, sometimes they do not joyn, but one empties it self into the left *Axillary*, and the other into the right.

'Tis to be observ'd, that this *Duct* opens into the *Axillary Vein*, sometimes above, and sometimes below the *Clavicula*, or *Channel-bone*; and that this *Axillary Vein* goes by the Name of *Subclavian*, from the *Clavicula* to the *Vena Cava*. This *Duct* is accommodated with Lymphatick Vessels, as well as the *Cistern*: For besides those of the Mesentery, Liver, and Spleen, that unload in the *Cistern*, from whence their Liquor runs straight into the *Duct*; there are others that run immediately into the *Duct* it self, particularly those of the *Pericardium*, *Thymus*, *Breasts*, &c. But after all, the *Cistern* and *Duct* are not the only parts into which Lymphatick Vessels are empty'd. They disburthen themselves into the Veins, and the Lymph serves to dilute the Blood; for instance, two springing from the Head empty themselves in the *Subclavian Veins*; some in the Arms run into the *Axillary Veins*, &c.

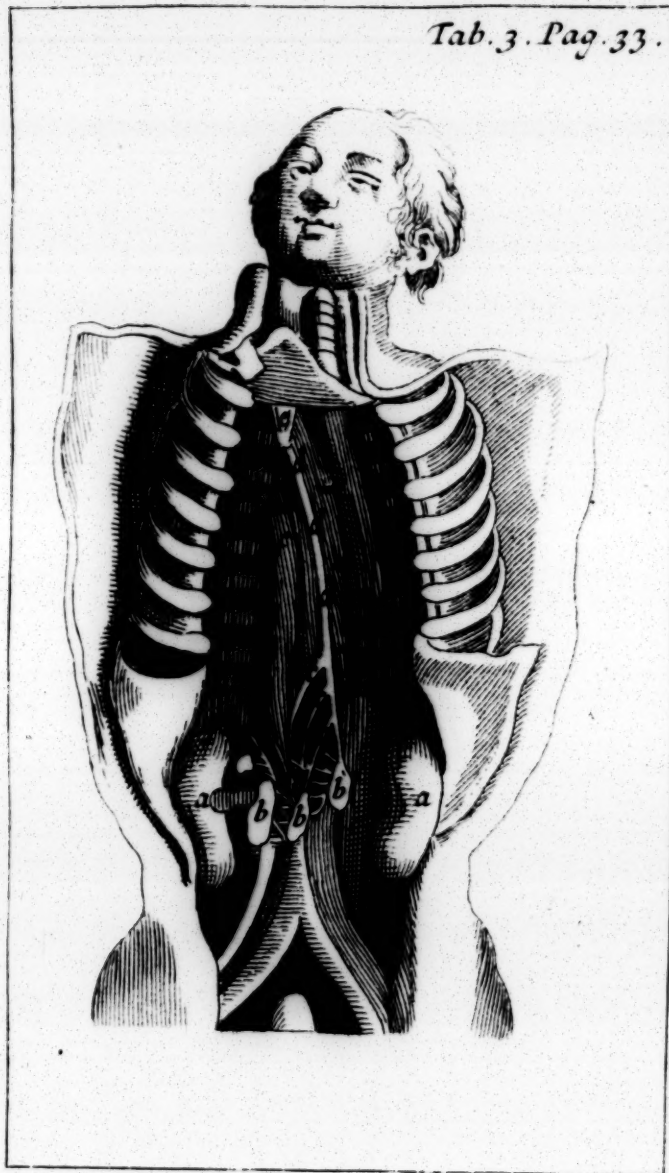
The distribution of the Chyle from the *Thoracic Duct*, is a matter of great difficulty. *M. Bils* alleges, that some Milky Pipes runs from that *Duct* to the Breasts. But 'tis very probable, he mistook the *Lymphatick Vessels* running from the Breasts to the *Duct*, for *Milky ones*: For tho' 'tis probable all the *Venæ Lactææ* are *Lymphatick Vessels*, yet all *Lymphatick Vessels* are not *Venæ Lactææ*.

The Chyle is a white, oily, soft Liquor, very like to Milk. It contains a quantity of Sulphurs and Spirits, and some Saline Juices.

'Tis easie to conceive how Milk is turn'd into Chyle: But 'tis a difficult Point to explain how all sorts of Aliment, whether sweet, salt, sour, white, black, grey, or red, should produce a Chyle, that bears so near a resemblance to Milk. 'Tis true, that in all sorts of Food there are still some parts, that in a separate state from the rest, are white, sweet, and liquid: And at that rate we must suppose, that the Orifices of the *Milky Veins* are so dispos'd, as to give reception only to these parts: But still there will remain this difficulty, that the Chyle is always grey in the Stomach: To which I would give this Answer; That commonly a grey Colour is produc'd, by coarse Sulphurs mix'd with many Saline parts, which makes the reflection of the Light to be somewhat short of that from a white Colour: And, as I take it, the ferment of the *Stomach* being full of Saline Parts, and the Victuals being full of coarse Sulphurs, these two must produce a grey mixture. But the *Venæ Lactææ* do only receive the subtilest and purest part, which gives an entire reflection to the Light. This I could make good by several Experiments; for instance: We see that *Plaister* pounded shifts its grey Colour for a white, and in preparing the *Lac Sulphuris*,



Tab. 3. Pag. 33.



phuris, and some other Chymical Preparations, 'tis manifest, that when the Sulphurs and Salts are purified, they become white.

T A B. III.

Representing the Glandulæ Lumbares, and the Ductus Thoracicus, as they are in Men.

- a a. *The Kidneys.*
- bb. *The Milky Glandules, which in Men are the Receptaculum, or Cistern of the Chyle.*
- cc. *The Branches it sends forth.*
- ddd. *The Thoracick Duct, form'd by the Union of these Branches.*
- e. *Its Head or Insertion into the Subclavian Vein.*
- f. *The Vena Cava cut up, &c.*

C H A P. IV.

Of the Alteration of the Chyle, in its passage through the Heart.

THE Chyle, having pass'd through the *Thoracick Duct*, into the *Subclavian*, or *Axillary Vein*; is from thence convey'd by the ascending Trunk of the *Cava*, into the right *Auricle* of the Heart. But 'tis question'd, if there is not another Line of Communication between the Chyle and the Blood.

Some have fancy'd, that there are two ways of Communication, taking the *Lymphatick Vessels* that carry *Lymph* from the *Liver* to the *Cistern*, to be *Venæ Lactææ*, carrying a part of the Chyle to the *Liver*. But that Opinion cannot stand; for when you put a Ligature upon these Vessels, they swell betwixt the *Liver* and the Ligature, and sink betwixt the Ligature and the *Cistern*.

Plempius imagin'd, that the Chyle passes along with the Blood into the *Mesaraick Veins*; and to favour that Opinion, 'tis alledg'd, that the *Thoracick Duct* bears no proportion to all the excretory Vessels that drain the Blood. But we do not find that these Veins open into the Intestines. However, let's consider the two Experiments that are insisted on as proof, by the Favourers of this Opinion. First, say they, if you put a Ligature upon the *Thoracick Duct*, the *Venæ Lactææ* will still unload, and the Animal will live still Twenty four Hours; which is an evidence, that they have some other way of emptying themselves. The Second Experiment is *M. Bils's*, viz. If you tie the

the Mesenterick Arteries of a living Animal after it has eat plentifully, and sew up the Abdomen, and suffer it to live some time, you'll find, when you dissect it, the Arteries empty ; and the Veins full of an Ashy-colour'd watery Humour.

To answer all these Difficulties, I affirm *that*, that watery Humour was Blood wanting its due redness, by reason of its not circulating, in order to receive the Air in the Lungs, to which the Blood owes its red Tincture. *Steno* made the same Experiment, and having expos'd to the Air both the Blood of the *Vena Portæ*, which he had ty'd, and that of the *Vena Cava*, he found that they became equally red. I try'd the same Experiment my self, and met with the same success. Now this Experiment makes it out, that there are more Chylous Parts mix'd in one Vein, than in the other.

As to the Experiment, I answer, that the disappearance of the *Vene Lactææ*, fills the *Cistern* and *Thoracick Duct*, insomuch they are at that time sensibly distended, and continue full above a Day. Now this would never come to pass, if they had any other Opportunity of emptying themselves.

To conclude. To confirm that all the Chyle passes through the *Subclavian Vein*, we shall quote *Dr. Lower's* Experiment, which I have often verified. He made an Incision on the Breast of a Dog, between the two lowermost Ribs, and open'd the Cistern of the Chyle, which was very full, because the Dog had eat but three Hours before : Upon which the Chyle run out at the Wound, and ceas'd to run in the *Thoracick Duct*. This done, he clos'd up the Wound, and gave the Dog as much Meat as he would eat : Some Days after he dy'd for want of Chyle ; and be-

Immediately dissected, his Stomach and Intestines were found very full, as well as the *Vena Lactea*; but the *Cistern* and *Thoracick Duct* were empty; and two Pounds of Chyle were found scatter'd and spilt in the Body. From this Experiment we conclude, that this is the only way of communication; for if there had been any other, the Animal had not dy'd, and all the Chyle had not been lost.

The same Author says, he made the same Experiment, by opening the *Thoracick Duct*, between the third and fourth of the uppermost Ribs, where the two *Thoracick Branches* use to joyn; and it had the same effect with the former. Thus it remains to be concluded upon, that all the Chyle runs into the *Subclavian Vein*, in all Animals, excepting Fowls, in whom the *Lactea* open into the *Vena Porta*. For tho' this Experiment does not carry along with it, all the convincing proof that might be desir'd; yet, if we consider that several Persons live without eating much, and that a great many live a considerable time with corrupt Matter, or Water in their Breasts; 'tis not conceivable why these Animals died, if so were that the Chyle had another passage into the Blood, besides that of the *Vena Lactea*.

After the Chyle is receiv'd in the *Subclavian Vein*, 'tis convey'd to the Heart; where its principal alteration commences. But 'twill be necessary to survey the Fabrick of the Heart, before we come to Reason upon the Transformation of the Chyle.

The *Heart* is a Muscle of a Pyramidal Figure, seated in the middle of the Breast, and inclos'd within the *Pericardium*; which is a Membrane continuous with the *Mediastinum*; and gash'd in five parts, by the ascending and descending
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Vena Cava; the *Aorta*, and the *Pneumonick Artery* and *Vein*.

The *Pericardium* is furnish'd with Arteries springing from the *Aorta*; and Veins that convey the Blood into the *Vena Cava*; and Nerves deriv'd from the Branch that supplies the *Heart*. 'Tis likewise furnish'd with some Lymphatick Vessels which transmit the Lymph to the *Thoracick Duct*.

There is a reddish Water lodg'd between this Covering or Chest, and the Heart; the Origine, Nature, and Use of which, will appear, after the Explication of the Use of the *Pericardium*. I am at a loss to conceive, how some Anatomists, that are otherwise Men of Understanding, should offer to assure us, that the *Pericardium* is of no use; and give it in for an instance of unactive and useless parts: For, supposing its Use were unknown, we ought not therefore to conclude that some parts are useless. 'Tis true, the Metaphysicks teach us to admit of nothing for a certainty, but what we perceive; but it does not direct us to deny all that we cannot conceive. So that upon this score, we ought rather to doubt and suspend our Judgment. If it be alledg'd, that this part has been found deficient in a dissected Dog; I answer, That the Allegation is incredible; and that 'tis infinitely more probable, that this Chest was tore, or exactly glew'd and united to the Heart, as it sometimes happens, even in Man himself. But a demonstrative proof of the use of this part, is this: That it has been always found in all Animals that ever were dissected, bating a Rat.

Blasius.

No Body can deny, but that this part skreens the Heart from the Corruption that may be hatch'd in the Breast. Besides, they cannot but own that it furnishes a Water which moi-

stems the external Surface of the Heart, in want of which it might be dry'd and wither'd by the continual and violent Motions 'tis oblig'd to perform.

'Tis question'd where the Source of this Water lies. Some alledge 'tis the product of Vapours, exhaling from the Heart, and imprison'd by the *Pericordium*. As to the Objection, that since these Vapours rise without intermission, the Water would swell to an overgrown quantity: *Diemerbroeck* answers very well; That the *Pericardium* enlarges its Dimensions. But, as I take it, he does not satisfy two other Objections. The first of which, is, That Liquors corrupt when they have no Motion. And the second runs thus: Since the Membrane and Flesh of the Heart are not capable to intercept and retain these Vapours, the *Pericardium*, which is less compact, will never do it. To which we may add, That we have Instances of several Persons taken off by Violence, in whose Bodies no such Water is found. Upon these Accounts, I reject that Opinion; for I cannot conceive, how Vapours should exhale through hard and thick Flesh. *Steno* says, The Lymphatick Vessels of the *Pericardium* furnish this Liquor: But these Vessels are so far from conveying any thing into the Chest, that on the contrary they carry Lymph from it to the *Chyle-Pipe* in the Breast.

Lower alledges, That there are Glandules at the Basis of the Heart, which strain out this Water: But the Allegation is groundless, there being no such Glandules to be seen. But after all, 'tis not improbable, that this Humour is the Lymph of the Blood filtrated in the Membrane of the Chest of the Heart; whether by the disposition of its Pores, or by virtue of some unperceivable Glandules seated in that Membrane. When this Liquor over-abounds, the Heart dilating

ting it self presses it up to the Membrane, and squeezes it into the Pores, which answer to the ends of the Lymphatick Vessels, which rise from this Membrane, and so convey the Liquor to the *Chyle-Pipe*, when its quantity renders it superfluous. When these Vessels are stopp'd, we are seiz'd with a fainting Weakness; by reason that the overflowing Water cramps the Heart, and hinders its motion.

This Liquor is of the same nature with the Lymph; for its consistence, taste, colour, &c. is the same: And both the one and the other, are equally apt to turn into a sort of Jelly, when expos'd either to Cold or Heat. Of which I shall treat more largely, when I come to speak of the *Lymph*.

'Tis to be observ'd, that in Men the *Pericardium* is fasten'd to the Nervous Centre of the Middriff; but is not so in four-footed Beasts. This fastning makes the Middriff, from being drawn too far down by the over-bearing weight of the Bowels in the Abdomen that hang upon it, when a Man stands upright. In Quadrupeds there's no occasion for such an Upholder; for the posture of their Bowels is such, that they rather press the Middriff into the Breast than draw it down into the Abdomen.

'Tis likewise to be observ'd, that sitting is the easiest posture: Because then the Thighs bear up the weight of the Bowels, and so they do not drag down the Middriff and Pericardium. And on the other hand, the uneasiest posture is that of being upon one's Knees on a level; for then the Bowels of the Abdomen bear downwards; and People continuing long in that posture, are apt to swoon, by reason that the Bowels pulling down the *Diaphragm*, and consequently the *Pericardium*, hinder the motion of the Heart.

The *Heart* is seated in the middle of the Breast, turning its lower point a little to the Left side, especially in Men; by reason that the *Vena Cava* springing from the Liver, grazes upon its Right-side, and so the Left side is less embarrassed. And in confirmation of this Truth, when the Liver and *Vena Cava* are pos'd on the Left side, which happens sometimes in preternatural Constitutions, the *Mucro* of the Heart is pointed to the Right-side.

The Heart is suspended by the Vessels that open into it. 'Tis compos'd of various parts: For besides its fleshy Fibres, 'tis furnish'd with Veins, Arteries, Nerves, and a Membrane that keeps all its parts close and compact. 'Tis surrounded by two Arteries springing immediately from the *Aorta*. The Veins empty themselves in the *Cava*. The Nerves make a *Plexus*, call'd *Plexus Cardiacus*, which is form'd out of the Eighth Pair, and the Intercostal; and furnishes Nerves to the Heart and Pericardium, and the neighbouring parts. 'Tis remarkable, that the Veins on one side of the Heart, communicate with the Veins on the opposite side; and the Arteries salute one another almost in the same manner.

As for the fleshy Fibres, 'tis doubted, if they are muscular; that is to say, if the Heart is a *Muscle*. *Hippocrates*, in his Book *de Corde*, says, the Heart is a very strong Muscle. Most Physicians who followed *Hippocrates* in every thing else, departed from him in this point. But *Steno* observing that the Heart is compos'd of fleshy Fibres, terminating in Tendons, and is furnished with a prodigious quantity of Nerves, chose to confirm and illustrate *Hippocrates's* Doctrine. In effect, the Heart is a Muscle, the fleshy Fibres of which make, as it were, two Rows, one without, and one within. The external

ternal Fibres are made fast at one end, round the great Artery. They run towards the tip or point, turning themselves Spiral-ways; and continue so to turn, till they arrive at the bottom, or basis, where they are ty'd fast on the Right-side, about the *Vena Cava*. Tho' all the external Fibres have one end fasten'd to the great Artery, and the other to the *Vena Cava*; yet there are several of 'em that do not reach to the *Mucro*, or Point of the Heart, but cross over from one side to another, about the middle of the Heart, and terminate where the others do. The internal Fibres are inserted at one end into the *Vena Arteriosa*. They cross the external Fibres obliquely, observing the same Spiral-turnings; and are most of 'em fasten'd at the other end to the *Arteria Venosa*. I said, *most of 'em*; because several Fibres do not run to the point; some turn off from the middle of the Heart, and form fleshy Columns, which are ty'd to the Valves, both of the *Pneumonick Vein*, and the *Vena Cava*.

In every Muscle, Anatomists distinguish a Head, a Belly, and a Tail; that is, one of the two points, where the two ends of the Muscle are fasten'd, is usually more movable than the other: And this being suppos'd, we must consider the two Rows of Fibres in the Heart, as being two Muscles. The first has its fix'd point in the great Artery, and its movable point in the *Vena Cava* on the Right-side. The fix'd point of the second Muscle, lies on the Right-side, round the *Pneumonick Artery*; and its movable point on the Left side, at the Vein of the Lungs. Now 'tis plain, that an Artery is not so pliant as a Vein. 'Tis that, that obliges the two Ventricles to empty themselves. The Extremities of the two Muscles are tendonous; and sometimes,
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like other Tendons, become Bony towards the Head of the *Septum Medium*.

The *Heart* has two *Ventricles*, sever'd from one another, by a very thick and compact Wall of *Flesh*, which hinders their communication. The right *Ventricle* has much fewer fleshy *Fibres*, and is much softer than the left: Each of 'em are furnish'd with a *Vein* and an *Artery*. The right *Ventricle* receives the Blood of the *Cava*, and throws it out into the *Artery of the Lungs*. The left receives the Blood from the *Pulmonary Vein*, and throws it into the *Aorta*.

The *Vena Cava*, and the *Pulmonary Vein* grow wider, before they enter the *Ventricles*; and form that which we call the *Auricles*, or *Ears* of the *Heart*; of which the right one drives the Blood into the right *Ventricle*, and the left into the left *Ventricle*.

The *Fibres* of the left *Ventricle* are stronger than those of the right; by reason that the Blood in the left *Ventricle*, is but just impregnated with fresh *Aereal Salts* in the *Lungs*, and these *Salts* insinuate themselves into its *Fibres*, and so render 'em stronger and firmer, and more vigorous and active, and more proper to throw the Blood into all parts through the *Aorta*. These *Salts*, by increasing the *Solidity* of the *Fibres*, do likewise shorten 'em; so that the left *Ventricle* is longer than the right, but not so broad.

The Structure of the *Auricles*, is equally admirable with that of the *Heart*. These *Ears* are *Muscles*, consisting of two Rows of *Fibres*, and two *Tendons*. One of these *Tendons* is fasten'd to the *Basiss*, or upper part of the *Heart*; and is common both to the *Fibres* of the *Heart*, and those of the *Auricles*. The other lies by the *Vein* which

which forms the *Auricle*. Some of their internal Fibres, make detach'd Columns, as it were; and the other external Fibres form likewise smaller Columns. These external and internal Columns lie a-cross, as the Rows of the Fibres do. These Columns ought to be look'd upon as so many little separate Muscles. The right Auricle is much larger than the left; by reason that the Blood is thicker, and moves more slowly in the right Auricle, than when it comes from the *Pulmonary Vein*.

Some Physicians, not minding this Reason, have imagin'd, that all the Blood of the *Cava* could not pass through the left Ventricle, tho' it did through the right, pleading that it was more rarified in the Lungs. But they should have consider'd, 1. That tho' the right Auricle is larger than the left, yet the right Ventricle is not larger than the left. 2. That part of the Serum of the Blood passes into the Lymphatick Vessels of the Lungs. And, 3. That the Blood moves more slowly in the *Cava*, and right Ventricle, than after its exit from the Lungs.

The Contraction of the Auricles precedes that of the Heart: They contract themselves when the Ventricles of the Heart dilate themselves; and each Ventricle receives the Blood thrown out by its respective Auricle, at every contraction.

Having thus dispatch'd the Fibres of the Breast, and its Auricles, we are now to take a View of its Ventricles.

There are some Fibres in the right Ventricle, which run a-cross its middle, and are fasten'd on one side to the Partition-wall, call'd *Septum Medium*, and on the other to the opposite Wall.

Wall. But in the left we meet with no such Fibres.

The Ventricles present us likewise with fleshy Columns and Valves. The Valves of the right Ventricle, are plac'd, either at the mouth of the *Cava*, or at that of the Pulmonary Artery. The Valves of the *Cava* are three in number, and make up a Membranous Circle : We call 'em *Tricuspides*. They're so plac'd as to look from without to the inside of the Heart ; and are ty'd fast by three or four tendonous Fibres to the fleshy Columns of that Ventricle. When the tip or point of the Heart enlarges its distance from the *Basis*, these Valves fall flat against the Walls, being pull'd by the Columns ; by which means the Blood gains an easie passage from the right Auricle, into the right Ventricle. But in the *Systole*, or Contraction, when the Point approaches to the *Basis*, these Valves are set at liberty ; and the Blood endeavouring to retire, pushes 'em up to the entry of the Vein ; and by that means stops its own passage on that side. Besides, the fleshy Pillars defend the Walls, from being over born by the Impetuosity of the Blood.

There are three Valves, call'd *Sigmoides*, which have the Figure of a C, and are seated in the right Ventricle, at the mouth of the *Pulmonary Artery*. Their posture is such, that they are easily run down by the Blood issuing out of the right Ventricle, in order to enter the *Pulmonary Artery* ; but when the Blood attempts to return, it shuts them, and so prevents its own retreat.

The Structure of the left Ventricle is much the same, bating that the Valves and fleshy Pillars are stronger and more compact, than in the right.

At the Orifice of the Pulmonary Artery, opening into the left Ventricle, there are only two Valves, which we call *Mitrales*, from their resemblance of a Mitre. They're plac'd like the *Tricuspidæ*, looking inwards; and are ty'd fast to the fleshy Pillars after the same manner with the Valves of the *Cava*. They have nothing peculiar, save that they're only two in number; but since the Pipe or Vessel is oval, two may serve to stop it exactly.

At the mouth of the *Aorta*, there are three Valves call'd *Semilunares*; which resemble the *Sigmoides* both in Figure and Office: For they allow the Blood to pass out of the Ventricle into the *Aorta*, and hinder it to return from the *Aorta* to the Ventricle.

The knowledge of the *Valves*, is very serviceable in pointing out the Course of the Liquors that circulate in the Body. But still there are some Difficulties that it does not remove: For instance: Why does not the Blood of the descending *Cava*, hinder that of the ascending to enter the right Auricle? Dr. *Lower* has well observ'd, that there stands a Rising, or Ridge of Flesh, between the two Trunks of the *Cava*, under the Auricle; which turns the Shock of the Blood in the descending *Cava* altogether, or almost altogether, upon the Heart, and diverts it from the ascending *Cava*.

After a due Consideration of the Structure of the *Heart*, 'twill be seasonable to offer some probable Conjectures of its use. But the following Remarks ought to be premis'd.

1. The Heart has the Structure of a Muscle. It moves like other Muscles; that is, it swells and grows hard; from which we may
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conclude, that its Motion depends upon the like cause.

2. The Heart has a Motion of Dilatation, and Contraction, which the Artists call *Diaſtole* and *Syſtole*. In the *Diaſtole* it opens and receives the Blood ; and in the *Syſtole* it squeezes it out.

3. When the Heart receives the Blood, it grows longer ; but when it expels it, it becomes shorter ; ſo that the *Diaſtole* conſiſts in the lengthening of the Heart, and the *Syſtole* in the ſhortning of it. This Propoſition is eaſily prov'd : For if you open a living Frog, you'll find the Heart turns white, and expels the Blood, when the Tip is drawn up to the Baſis ; but reddens when the Tip retires. And for a further Confirmation, if you thruſt your Finger into the Ventricle while the Heart beats, you'll find your Finger squeez'd when the Point comes up, and very eaſie when it retires.

4. During the *Diaſtole* of the Auricles, the Heart performs its *Syſtole* ; and while the Auricles perform their *Syſtole*, the Heart is in a *Diaſtole*. This is viſible in a Frog: For the Auricles redden, when the Ventricle turns white ; and when theſe redden, the others whiten.

5. *Arteries* have their *Diaſtole* and *Syſtole*. Their *Diaſtole* keeps time with that of the Auricles ; and by conſequence, their motion is oppoſite to that of the *Heart* ; that is, when the one contracts, the other dilates, and *è contra*.

6. If you pull out the Heart, it will beat ſtill : Nay, tho' you cut in pieces, it will ſtill retain a Pulſation ; eſpecially in Carps, Eels, &c.

Several Philoſophers and Phyſicians, have endeavour'd to explain the Motion of the Heart mechanically. Among all their Systems, there
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are three in great esteem, under which the rest may be couch'd.

Descartes supposes, that the Heart is possess'd of a Fire without Light, very proper for rarifying the Blood, which, according to his System, falls by drops into the Ventracles. And accordingly alledges, that the Blood is in the same Condition, with other Bodies that are apt to rarifie, when pour'd by little and little into a very hot Vessel ; such as Milk, Oyl, &c. The *Vena Cava*, says the Philosopher, drops a drop of Blood into the right Ventricle, and the *Pulmonary Vein* drops another into the left Ventricle. These two drops of Blood, continues he, enlarge their dimensions, and press up the Valves of the Vessels from whence they came, and so prevent the ingress of fresh Blood. In the mean time, the drop that's within, is rarify'd more and more by its stay ; upon which the Heart swells, and the Valves of the Arteries are open'd, and the then rarify'd drop entring the Arteries, heaves them up ; after which, the Heart and Arteries sink, and give admission to a fresh drop of Blood in each Ventricle : And this drop being rarify'd in like manner, produces the same effect as before.

This System, I take it, is contrary to Experience : 1. The Blood is not of a nature so very proper for rarification. 2. The Heart has not sufficient heat for such a rarification. 3. The Heart is so far from shortning it self when it receives the Blood, that in effect it is then lengthen'd : Which, in my Opinion, does absolutely overthrow the advances of this mighty Physician. 4. The Systole of the Heart is contemporary with the Diastole of the Artery, and the dilated Artery receives the Blood, when the contracted Heart squeezes it out.

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The second Opinion is : That the Motion of the *Heart* is owing to the Spirits rang'd in the fleshy Fibres ; which by falling now into the internal, and now into the external Fibres, occasion alternate Dilatations and Contractions. But the falsity of that thought is easily made to appear. 1. The internal and external Fibres act jointly, and at the same time : They are both *Spiral* ; and all that either of 'em can do, is to straiten the Heart, by shortening themselves. 2. We find a little beating Bladder, or Bottle, which can be nothing else but the Heart, in a brooded Egg, before the Brain of the Chick is form'd, and consequently before the existence of Animal Spirits : So that the Motion of the Heart has no absolute dependance upon the Spirits.

The third System advances, that the Motion of the Heart depends upon the Spirits and Blood. 'Tis alledg'd, that the Spirits swelling up the Fibres of the Heart and Auricles, keep 'em always shorten'd, and upon the spring, which they call the *Systole*, because the Cavities are lessen'd when the Fibres are shorten'd ; but that the Fibres of the Auricles, and those of the Heart, are not contracted at the same time. Thus when the rebounding spring of the Fibres is weaken'd, and the Blood of the Veins imploy both its weight, and the impulse it receiv'd in its progress, to make way, it gains entrance into the Auricles. But after that, the impulse of the Blood ceases, and the spring of the Auricles increases ; by reason of the perpetual Recruits of fresh Spirits ; and the Fibres straiten the Cavity, so as to expel the Blood into the Ventricles, being assisted for that end by the Blood's own weight. After this effect, the impulse ceases, and the Ventricles retrieve their former vigor ; and empty the Blood
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into the Arteries, which they could not throw into the Veins by reason of their Valves. This Scheme is mechanical indeed; but it does not fully account for all the *Phænomena*: As, 1. When you take out the Heart of an Animal, it should not beat at this rate; since there remains almost no other force but that of its Spring, which keeps it always contracted; and there is no Blood, to make a Diastole. But after all, 'tis Matter of Fact, that its dilatation and contraction are very near equal. 2. If the Blood were the Author of the Dilatation, when once it has master'd the spring or contracting force, it would still keep open Doors for the following Blood, and the continual Flux would be so great, that the Muscle would never be able to recover a Contraction: For the current of the Veinous Blood is always equal, since it does not flow with Jolts as it does in the Arteries. So that the force of the Blood would not be impair'd by its opening the Heart; since at that rate the Heart would be only a simple Thoroughfare, without any Pulsation. 3. The Heart moves in the little Bottles above-mention'd, notwithstanding the absence of the Animal Spirits.

As none of the above-mention'd Systems is capable to satisfy an accurate Physician; so I am oblig'd to acknowledge, that the Scheme I propos'd in the first Edition of this Treatise, does not satisfy my self. 'Tis true, 'tis not expos'd to all the Difficulties that attend the others; but 'tis impossible to screen it from some: For it may be justly said, that all the Contrivers of Systems are short, in not explaining the Physical Cause, of what they lay down by way of supposition. That is, they suppose that the whole Machine of the Body is in motion, and that the Liquors flow in their Vessels: Now,

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they should have found out , and explain'd the Cause of those different Motions. Tho' that be a thing of the greatest importance, yet no Man has trac'd it. I presume, the Explication I am about to give, will satisfy those who consider, that we know of no other Agents for putting this Spring in motion, but those I have insisted on ; and that, I suppose, in a manner, nothing that is not demonstrated, and conformable to all the known *Phænomena* : And moreover, that my Explication reaches several Effects that are not accounted for in any other System. 'Tis a plain, accurate Scheme ; but indeed the whole is owing to the Thoughts of a Friend, who was so kind as to impart it to me. I doubt not, if my Friend had publish'd it himself, he had set it off to better advantage : But as rough as the Draught is, 'twill still discover the justness and quickness of his Thought.

In order to find out the cause of the Motion of the Heart, we must premise, that the Blood of the *Vena Cava* passes into the right Auricle of the Heart, and from thence into the right Ventricle ; that in the like manner, the Pulmonary Vein empties it self into the left Auricle , and the left Auricle into the left Ventricle ; that after that, the two Ventricles empty themselves into the two large Arteries inserted in 'em ; and that these Arteries, after being divided and subdivided into several small and almost insensible Branches, meet at the end with little Veins, which re unite, and run into the great Veins now mention'd.

Tho' this communication is not obvious to our Senses, yet 'tis made to appear by clear demonstration. 'Tis further necessary to call to mind, that the Ventricles of the Heart empty themselves, and fill the Arteries, at the same time
that

that the Veins disburden themselves into the Auricles; and that in like manner, the Contraction of the Arteries is contemporary with that of the Auricles; and both these are contemporary with the dilatation of the Ventricles of the Heart; and reciprocally the Contraction of the Ventricles of the Heart, is contemporary with the dilatation of the Auricles and Arteries. This supposes an alternative Motion between the Auricles and Ventricles of the Heart, and between the Ventricles of the Heart and the Arteries, as well as between the Arteries and Veins, and between the Veins and the Auricles. But after all, it is to be observ'd, that the Motion of the Veins is unperceivable; and that the Heart cut out, and separated from the Veins and Arteries, retains its Pulsation a long time, and its Motions are alternative, notwithstanding their irregularity.

In this place I am only in quest of the cause of one of these Motions, *viz.* that of Contraction; for, as I take it, the Motion of Dilatation is sufficiently accounted for, by the necessity that a neighbouring part lies under, to receive the Blood when thrown upon it by the contracted part.

In order to explain all these different *Phænomena*, together with those I mention'd above relating to the Motion of the Heart; let's mind the following Remarks: 1. That the Veins and Arteries are furnish'd with Fibres, some circular, and some running length-ways, which intersect one another. 2. That the long Fibres are not always parallel, but lie a-cross one another in several places. The same may be apply'd to the circular Fibres. 3. That the long and circular Fibres do not joyn so close, as not to leave some little Intervals between 'em, which may be considered as so many Chinks, somewhat oblong.

4. That these Chinks are larger in the Veins than in the Arteries. 5. That the subtile Matter ranging in these Chinks, must needs shorten the long and circular Fibres, by shoving them aside, and consequently impair both the length and width of the Vessel. We see every Day, that a Rope abridges its length, when Water, or any other Liquor swells it. 'Tis well known by the Rules of Mechanism, that any Liquor passing through a Chink, endeavours to enlarge it, since that which offers to pass cannot be always of an exact size, but every now and then surpasses the just Dimensions of the Chink; in which case it does the office of a Wedge. And therefore we are not to doubt, but that the subtile Matter ranging through the Fibres of the Veins and Arteries, is capable to enlarge their mutual distances, as well as in all other Bodies, and to alter the Figure of the Interstices. Thus those that were oblong, may become round. This subtile Matter may likewise swell the Fibres, and consequently make them shorter. Now all this must needs bring down the width and length of the Vessel to a certain size. That suppos'd, I say, the Veins contracting themselves, and abridging their length and width, do, by virtue of this Spring deriv'd from the subtile Matter to their Fibres, drive the contain'd Blood into the Auricles: For the Blood being oblig'd to depart, and the Disposition of the Valves opposing its retreat into the Arteries, it cannot but repair into the Auricles. Since the contraction of the Vein runs all along the Vessel, it follows, that notwithstanding its being unperceivable, it certainly squeezes out at the extremity of each Vein a large drop of Blood; which being of it self possess'd of a Spring and considerable Impulse, being penetrated by the subtile Matter, and pusht

on by the Vein, makes its way into the Auricle. This Auricle has a Spring as well as the Vein, and indeed a greater one ; for it enjoys a greater number of Fibres, and those much more compact ; and so the subtile Matter ranging through its Fibres, and the contain'd Blood, does at once rarifie the Blood, and shorten the Fibres of the Auricle ; by which means, the Blood being hindred by the Valves to return into the Vein, is expell'd into the adjacent Ventricle of the Heart, where its entrance is free. This Ventricle is furnish'd with a much greater number of Fibres than the Auricles, so that when its Fibres are shorten'd by the Impulse of the subtile Air enlarging their Intervals, the Tip or Point is drawn up to the Basis ; upon which, the Cavity of the Ventricle is lessen'd, and the Blood, which cannot return into the Auricles, their Mouth being shut by the *Tricuspid* Valves, is forc'd into the Arteries, where the *Sigmoides* Valves give way for its passage.

The Arteries which give way to the Impulse of the Blood, are afterwards contracted by the influence of the subtile Matter that splits and separates their Fibres ; by which means they squeeze out into the Veins a quantity of Blood, almost equal to that they receiv'd from the Heart. After the evacuation of the Arteries, the Spring of the Arterious Blood, which consists in Rarification, is much weaken'd, and the Spring of the Artery having now squeez'd out a certain quantity of Blood, is not capable to go further. 'Tis manifest, that the subtile Matter makes only a certain removal of the Fibres, beyond which it cannot go : For instance ; if the Chinks are oblong, and the strugling of the subtile Matter makes them round ; I cannot conceive, that the mutual departure of the Fibres, and the contraction of the Artery, can continue beyond the

extent of that cause. This is one of the principal Reasons why the spring, or contracting force, does not always rise and increase; and likewise, why it gives way to the impulse of the Liquors, which, by dilating the Vessel, restore the wonted figure and narrowness of its Pores. Add to all this, that the Fibres of the Veins may have the same disposition of Pores, with the Fibres of the Ventricles of the Heart; and I know no reason, why the Pores of the Fibres of the Arteries, and Auricles, may not have a mutual resemblance, and a disposition quite different from that of the Heart and Veins. Let's suppose then a sort of opposition between these antagonist Figures; particularly, that the Veins have larger Pores than the Arteries, which is an undisputed Truth. Now the subtile Matter having such a compofure of parts, that sometimes the coarser over power the finer, and sometimes the fine parts out-number the coarse; this being the Composition of the subtile Matter, it will redouble its efforts at one time, in splitting the Fibres of the Veins and Ventricles, and at another in enlarging the Pores of the Auricles and Arteries; and consequently at one time will contract the Veins and Ventricles, and at another time the Arteries and Auricles. And this, I take it, is one of the principal Causes of the alternative Motions of the Heart, especially when 'tis separated from its Trunk.

Perhaps it will be objected, that since the Arteries have a much greater spring than the Veins, they shou'd squeeze out a greater quantity of Blood into the Veins, than the Veins can drive into the Auricles; which wou'd sink the œconomy of the Circulation. To remove this difficulty, I propose the following Remarks: 1. That as the Arteries have a greater spring than the
Veins

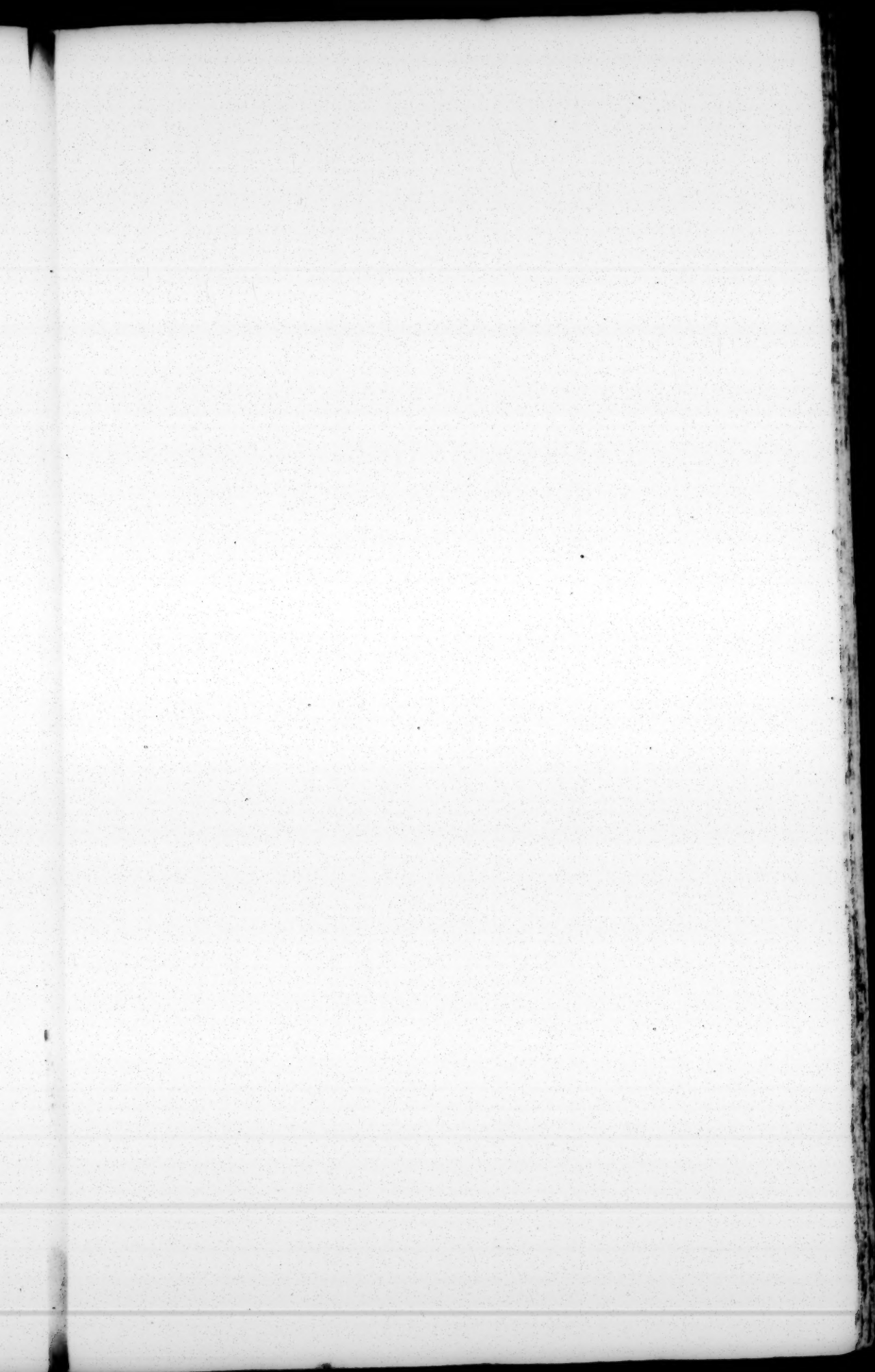
Veins, so they have less bulk. 2. That the Arterious Blood being more rarified by the Air in the Lungs, has a scatter'd and weaker spring. 3. That a much greater force is required to squeeze out a certain quantity of Liquor when it is rarified, than when it is not; by reason that the rarifying Air, or subtile Matter, slips out at the Pores.

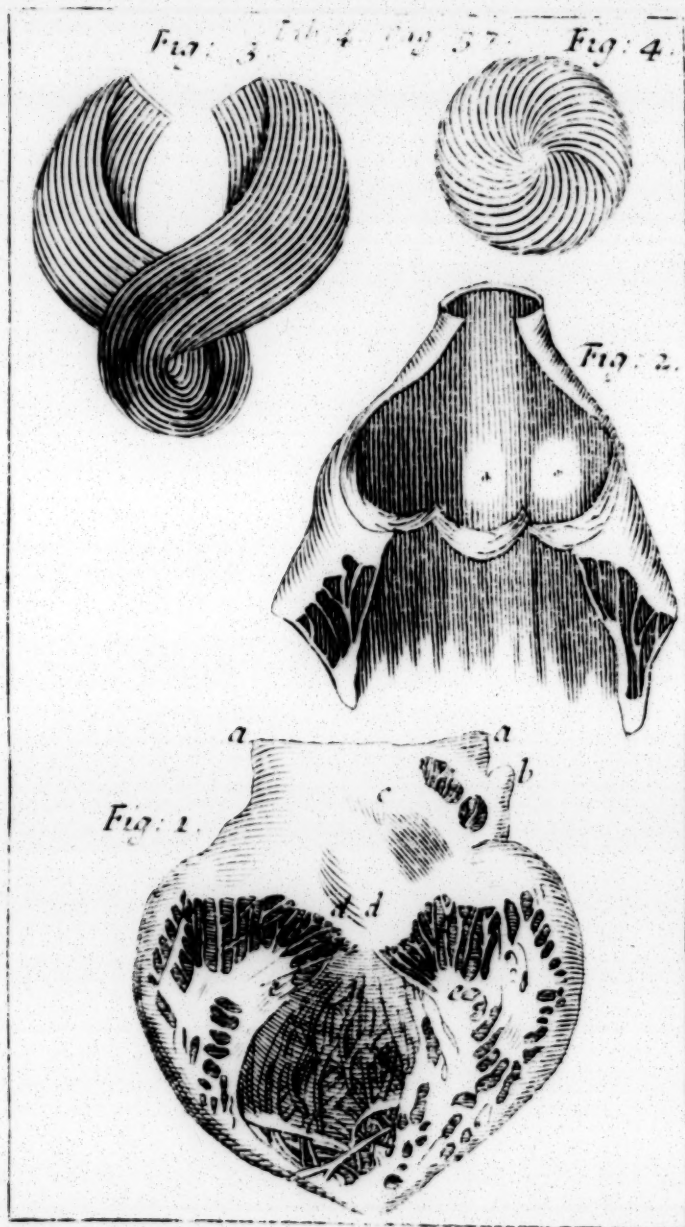
It may be further objected, That since the subtile Matter does equally penetrate all Bodies, it should make the Alternations of the Pulse equal in all Animals, whether young or old, feverish or not feverish; which is known to be false. This difficulty will easily be remov'd, if we observe, that the Cause of the Alternations was not thrown altogether upon the sole magnitude of the Pores of the Veins and Arteries; but upon that in conjunction with the greater and lesser rarification of the contain'd Blood. Now 'tis manifest, that the Blood will be more or less rarified, according as its parts are more or less apt to be mov'd, upon their respective Centers, by the subtile Matter: For 'tis to be observ'd, that rarification is only occasion'd by the motion of each part upon its own Center; which, before the rarification, was not at all mov'd in that fashion. And forasmuch as every part that is not exactly round, will require more space than it did before, so the whole Mass in general will likewise require larger Bounds. 2. When a Liquor demands more room, and does not find it, 'twill endeavour to accelerate its pace, and in effect will run more swiftly, if it meets with no obstacle. 3. The Particles of Blood in feverish and young Persons are very apt to rarifie; this aptness to rarifie seems to proceed from the proportional inequality of the parts; on which occasion, the little fine Particles are easily put in motion round their

own Center, by the subtile matter ; and these communicate their motion to the parts that are somewhat coarser ; and these again to the next degree of coarser parts, and so on. But when the Blood is quite destitute of one or two of these gradual differences among its parts, 'tis more difficult to rarify it ; that is to say, it both requires a longer time to rarify, and its rarification is not so great.

It may be objected in the third place, that 'tis not at all probable, that the subtile Matter is compos'd of fine and coarse parts, in so just a proportion as to regulate the Alternations of the Pulse, &c. I answer, That there's no such Exactness requir'd ; for if we examine the subtile Matter, which questionless enjoys a diversity of parts, we'll find that it begins to play upon either the Veins or Arteries, by contracting them ; and as soon as one, for instance the Artery, is contracted, the other, for instance the Vein, is dilated ; and its Pores are straiten'd, while those of the Artery are enlarg'd to a determin'd degree, or to a certain point, at which the subtile Matter turns its action upon the Pores of the Veins and Ventricles : And then the Pores of the Arteries are lessen'd in their turn ; and that alone is sufficient. As for the time which the subtile Matter spends in making the oblong Chinks round ; the determination of that space of time is less owing to the subtile Matter that causes the Spring, than to the Fabrick of the Spring itself, which can scarce be either swifter or slower.

The use of the Heart, is, to receive the Blood from all the parts of the Body, and to remit it by the Arteries into all parts. Thus it is the principal Organ of Circulation, being so very serviceable, whether in conveying the Blood to all the parts of the Body, or in mixing and incorporating





porating the Chylous Particles with the Blood ; or, in fine, in subtilising and refining the Blood, both by grinding and squeezing it in its Ventricles, and by putting it in a rapid Motion. This is the general use of the Heart. As for the particular Uses of its several parts, I have already given them ; or, at least, have advanc'd such Ideas as will easily direct you to them.

T A B. IV.

Fig. 1. From Dr. Lower.

Representing the Orifice of the left Ventricle.

- a a. *The Pulmonary Vein laid open.*
- b. *The left Auricle.*
- c. *The Foramen Ovale, visible in a Fetus.*
- dd. *The Mytral Valves, which favour the entry of the Blood from the Pulmonary Vein into the Heart, and hinder its retreat into the said Vein.*
- ee. *The fleshy Pillars.*
- ff. *The Fibres supporting the Mytral Valves.*
- gg. *The small Columns.*
- h. *The passage under the Mytral Valves, which convey the Blood into the Aorta.*
- i. *The Mucro, or Point of the Heart.*

Fig. 2.

Represents the Orifice of the right Ventricle opening into the Pulmonary Artery ; where the Sigmoides Valves allow of the Blood's departure from the Heart into the Pulmonary Artery, but oppose its return to the Heart.

Fig.

Fig. 3.

Represents the fleshy Fibres of the Heart, turning round towards the Point.

Fig. 4.

Represents the Fibres of the tip of the Heart.

C H A P. V.

Of the Composition of the B L O O D.

TH O' the Blood differs from the Chyle, and the Chyle from the Aliment, 'tis nevertheless very certain, that the Blood and Chyle are possess'd of parts, which resemble those of the Aliment, and differ from 'em but very little, upon the score of their greater or lesser Motion. However, these parts being disunited from the other parts of the Aliment, and mix'd up in a new fashion, cannot but make a quite different appearance, and be employ'd for different uses, when they are in the Veins. Those Alimentary Particles which roll in our Vessels, are of a reddish yellow colour, and sprightly, when lodged in the Arteries; but in the Veins they are of a reddish brown, and much duller: Which seems to prove, that Motion is one of the principal Causes of the Transformation of Liquors in our Bodies. On the other hand, it cannot be deny'd, that the same Alimentary Particles seem to assume new forms every Minute, according to the variety of their mutual separation or combination.

tion. Thus the *Saliva* and *Bile*, which are not to be seen in the Blood, no more then Seed, Milk, Ear wax, &c. have nevertheless a real existence in the Blood; for whenever their respective secretory Sieves separate their Particles from the rest, they are plainly perceiv'd in their Cisterns. When the Air has separated the parts of Blood drawn out of the Body, we may distinguish the Fibrous part from the Serous; that is, we perceive the coarser parts link'd together like Threads, and form'd into a Curd, while the other continue their Liquid State. And when we examine a drop of Blood newly drawn, with a Microscope, we perceive round and longish parts, swimming and rolling in the clear Liquor.

In preparing Gunpowder, 'tis manifest, that the parts of the Coals, Sulphur, and Saltpetre, must be mix'd in a certain particular way, before they can produce the wonted effects: In the like manner, the parts of the Bile, Spittle, &c. must be mix'd in a particular way to appear in the form of Blood.

We must allow the Blood to have many parts of different figure and magnitude. 'Tis undeniable, that it contains Serous, Urinary, Salivary, Bilious, Seminal, Milky, and Lymphatick parts; which have, all of 'em, their peculiar figure and magnitude. Tho' all these Liquors differ from one another, they have still some common parts; for instance, it is probably conjectur'd, that the *Saliva*, the Lymph, the Bile, and the Serum, have some similar parts, tho' the gross of all their parts is very different. In treating of the *Saliva*, I reckon'd up a great part of the Principles of these Liquors; and shall only add, that all these different Liquors differ vastly from those of their own form in different Subjects. For tho' 'tis true, that the greater or lesser quantity of *Saliva*,

Saliva, Bile, Oyl, &c. in the Mats of Blood, does vary the Temperaments of Men very considerably ; I am still perswaded, *that*, that is not sufficient ; and that the Principles of the Saliva, or Bile, in one Constitution, are different from those in another. 'Tis a hard matter to trace this matter to the bottom : For, without an infinity of Reflection, upon the Quantity of the Saliva voided by the Man, upon his Appetite, his Digestion, the Freedom of his Belly, the Quantity of his Urine, the Condition and Habit of his Body, the Pulsation of his Arteries, the Exercise of his Body and Mind, his Passions, &c. 'Tis impossible to be fully acquainted with his Temperament, *i. e.* The Figure, Magnitude, and Quantity of the liquid Particles that roll in his Vessels. Without doubt the greater or lesser Quantity of Spittle, the greater or lesser Appetite, the difference of Tastes, the good or bad Digestion of a certain sort of Food, will discover the Disposition and Quantity of the Salivary Particles, and of the Stomachick Ferment in our Blood : The Condition of the Belly, will speak the abundance or deficiency of Bilious Particles ; the fineness of the Bones, will intimate a want of such parts as are calculated for the nourishment of Bones, &c. And to sum up all, the Blood expos'd to the Air, acquires a lively redness ; yet all Men's Blood does not equally redden : From whence we may infer, that a due Examination of the Blood, might furnish us with Conjectures upon the difference of Constitutions.

C H A P. VI.

Of the Change which the Blood undergoes in the Lungs.

TO understand the Manner of the Blood's Passage through the Lungs, we must suppose, that the Lungs swell when the Air enters into 'em, and sink when it departs: Of which more elsewhere.

The Lungs are a soft spongy Body, seated in the Breast so advantagiously, that it has room to swell. They're cover'd with a strong thick Membrane, and are divided by the *Mediaſtinum* into two *Lobes*, each of which is compos'd of several Vesicles, or little Bladders, which communicate one with another, each of 'em being furnish'd with Veins, Arteries, Nerves, and Lymphatick Vessels.

I consider the Lungs as representing a Bunch of Grapes wrapt up in a Cloth: For the *Lobes*, which were discover'd by the late famous *Malpighi*, first Physician to Pope *Innocent XII.* may justly be compar'd to the little Clusters, of which the Bunch is compos'd; and as every Cluster contains its Berries or Grapes, so every *Lobe* has its lesser *Lobes*; and the Branches of the Windpipe which terminate in every Lobe, bear a near resemblance to the small Branches upon which the Grapes grow.

Malpighi observ'd Intervals between these Lobes, which are not simple Cavities, but Vesicles compos'd of two Membranes, one of which is a continuation of the Membranes of the Windpipe,

pipe, and the other a continuation of the Membranes of each Lobe.

Some of these Interstices are *Parallelipipedums*, some Cubes, some Spherical, and some of irregular Figures. All the Lobes have a mutual communication by holes ; and are found in great numbers, behind the outer Membrane of the Lungs. They are full of Air, and incompass'd with a String of Veins and Arteries.

One would think that the Interstices of the Lobes shou'd receive the Air, since their Membranes are deriv'd from the Windpipe, and the Lobes themselves : But we find by Experience, that if you blow up the Windpipe, these Interstices will not swell, but the Lobes will ; and on the contrary, if you open one of these Interstices, and blow into it, the whole Substance of the Lungs will swell, and the Intervals between the Lobes will be much enlarg'd, notwithstanding that the Lobes don't seem to rise at all. From this Experiment some conclude, that the Interstices receive no Air. Dr. *Willis* fancied, that the Vessels encompassing these Interstices, raise a Vapour, which turns into Water, and enters the Lymphatick Vessels, that creep along the external Membrane of the Lungs. But in regard the Humours of our Body are separated from the Blood by Filtration only, and never by Evaporation, we may conclude, that this Lymph is strain'd out, either in the Membranes of the Lungs, or in some Glandules. 'Tis observ'd, that the Lungs cut out of an Animal, float in Water ; which proves, that after Expiration, the Lungs are not altogether void of Air ; and from thence we may infer, that these Interstices contain a sort of Air that is not expell'd by each Expiration : Not that this Air is not convey'd by the Windpipe ; but only that it
finds

finds difficulty to get out of the Interstices, and there coming in but a little at ev'ry inspiration, we are not to think it strange that the swelling of the Interstices is insensible: But on the contrary, the Air of the Lobes is expell'd at every turn of expiration; for besides that their Pores are very patent, and that they've very large passages for admitting and expelling the Air, they are furnish'd with fleshy Fibres to promote the Contraction.

The Lungs have several sorts of Vessels; particularly those which bring and carry away the the Blood, besides Nerves and Lymphatick Vessels.

The *Aspera Arteria*, or Windpipe, is a passage from the Mouth to the Lungs. 'Tis compos'd of Membranes and Cartilaginous Rings, broke, or open, on the back part; I mean, that part which touches the Gullet. It has three Membranes. The innermost Membrane is nervous and glandulous, and strains out a Liquor that continually bedews the inside of the Pipe, to prevent its being dry'd up by the Air. The middle Membrane is fleshy, and performs the contracting part, by putting together the two broken ends of the Cartilaginous Rings. The outer one is strong and tendonous: It covers the Cartilages, and the other Membranes, and keeps 'em from being over-dilated. The Head of the Windpipe is call'd the *Larynx*; but I shall not insist upon it at present, since 'tis rather an Organ of the Voice, than of Respiration.

When the *Trachæa* splits or divides it self in the Lungs, its Rings are broke in three or four pieces, so that the fleshy Fibres can easily straiten them. You must observe, that the *Trachæa* is split into as many Branches as the Lungs have Lobes; and then each of these Branches is subdivided into as many smaller Branches, as every
Lobe

Lobe is into smaller Lobes : Infomuch, that every little Lobe may be call'd a sort of Lung, just as every Cluster may be call'd a small Bunch.

The Substance of the Artery of the Lungs, is, like that of the other Arteries, almost Cartilaginous. It rises from the right Ventricle, and conveys the Blood to the Lungs. Every Branch of the Windpipe has a Branch of this Artery under it : So that it is divided at the same rate with the *Trachea*, till a Branch from each of 'em has reach'd the smallest Lobes. But after that the Blood Vessels extend their Branches a little further, and form a sort of *Plexus*, or Strings round the Interstices, which one may easily descry with a Microscope.

The Pulmonary Vein rises from the left Ventricle. 'Tis divided and subdivided at the same rate with the Artery ; and detaches the same Branches which form the *Plexus*. It lies under the Windpipe ; so that when that Pipe is dilated by the Air, it presses both this Vein and the Artery, and makes the Motion of the Blood greater and stronger.

Besides these two great Blood Vessels, which make all the Blood in the Body to circulate thro' the Lungs ; there is a Vein and an Artery that serves to nourish the Lungs. The Artery comes from the *Aorta*, and the Vein runs into the *Vena Cava*.

The Lungs are also furnish'd with Nerves and Lymphatick Vessels. The Nerves are deriv'd from a Branch that parts with the *Par Vagum*, near the Region of the Heart, and disperses its Branches to all the Lobes. The Lymphatick Vessels rise out of the Surface of the Vesicular Cells, or the Interstices, and creep along the outward Membrane of the Lungs, and at last empty

empty themselves into the *Thoracick Duct*, and the adjacent Veins.

Having thus explain'd the Structure of the Lungs, we are now to enquire into its Uses. 'Tis plain, that when the Ribs heave themselves up, they push the external Air ; which, finding no other space to lodge in, but the Cavity of the Breast, enters through the *Larynx*, and Windpipe, and blows up the Lobes of the Lungs : This we call *Inspiration*. After that, part of the Muscles of the Breast bring down the Ribs, and lessen their Cavity, and by consequence squeeze the Air contain'd in the Lobes, and expel it by the Windpipe : This we call *Expiration*. In this last Operation, the shortning of the fleshy Fibres of the Lobes, and of the Branches of the *Trachea*, may give assistance : For, in dissecting a live Frog, we see the Lobes squeeze and empty themselves only by the spring of their Fibres, without any assistance from the Muscles of the Breast.

Frogs have a particular Organ, that serves them for *Inspiration*, independently of the elevation of the Breast. 'Tis a small Skin under the Throat, which is a little hollow, and lodges its Convexity in the Throat ; but by extending it self becomes straight, and, by pressing the external Air, forces it to enter the Lobes.

From what has been said, we may gather, that in *Expiration* the Blood repairs to the Lungs in a larger quantity than in *Inspiration* ; and by the same consequence, that a greater quantity of Blood is squeez'd out of the Lungs in *Inspiration*, than in *Expiration*. The quantity repairing to the Lungs in *Inspiration*, is lesser, for two Reasons. The first is, That the dilated *Trachea* bears down upon the Blood-Vessels, and so hinders the Artery to receive so much fresh

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Blood.

Blood. The second is, That the Lobes being much swell'd, or blown up, press the internal Air contain'd in the Interstices ; and that Air being straiten'd, bears hard upon the Vessels of the *Plexus*, which hinders them to receive so much fresh Blood ; but the same pressure causes the blood in the Veins to run more swiftly.

Some have objected, That a greater quantity of Blood should repair to the Lungs in *Inspiration*, than in *Expiration* ; because the Branches of the *Trachæa*, by swelling and lengthning themselves, stretch out the Vessels that accompany 'em ; by which means the Liquors contain'd in 'em, will have an easier circulation. And on the other hand ; in *Expiration* the Blood-Vessels being folded, as 'twere, one above another, their Liquors must circulate with greater difficulty. To this Objection, one might tack another, *viz.* That 'tis very probable, that when the Lungs are press'd by the Middriff and the Ribs, they squeeze out more Blood than they receive. And 'tis certain, that in *Expiration* the *Lungs* are press'd by the Middriff and the Ribs, and that in *Inspiration* they are free from all pressure.

To answer these two Objections, we are to observe, That the Blood-Vessels in the Lungs, are always straight enough to give the Blood a free circulation ; and since there always remains some Air in the Interstices, the Vessels are neither sunk nor wrinkled in the Expiration ; For, after Death, if you dip the Lungs in Water, they'll rise to the Surface, by virtue of the great quantity of Air that still remains within 'em.

As for the first Objection ; The pretended stretching of the Vessels, cannot advance the freedom of Circulation, since they are not lengthen'd or stretch'd, more than they're press'd and flattend.

flatten'd. The second Objection is equally weak ; for the Lungs are far from being more press'd in Expiration, since on that occasion they expel a great quantity of Air, that may easily slip out, and consequently their Membranes are looser, and have less spring ; so that the Arterious Blood endeavouring to enter, may rush in to a large quantity, because it meets with little or no resistance. On the contrary, in *Inspiration*, the pressure is very great ; for the Lungs being stuff'd with Air, and their external Membrane being of a pretty firm Texture, and not very porous, the Air will press all the Blood Vessels, and by virtue of that pressure, give an impulse to the Blood in the Veins, and at the same time hinder the Arterious Blood to enter into the Lungs.

The Blood, which, in the Veins, is of a brownish red Colour, assumes a rutilant red, after it has pass'd the Lungs. And since the Blood undergoes no other change in the Lungs, but either its mixture with some parts of the Air, or the motion impress'd upon it by the Air ; 'tis probable, that its mixing with the Air, does only produce that effect ; for the more we expose Blood to the Air, we find it acquires the brisker redness ; and the more we pump out the Air from it in an *Air Pump*, its redness is the paler. The Reason of these Effects, is to be fetch'd from the Physical Causes of Colours, the attempting of which would lead me too far out of the way. Upon this occasion, 'twill be sufficient to intimate, that a great many Experiments assure us, that the Air contains a great quantity of earthy Salts, that resemble Saltpetre very much, and have been rais'd out of the Earth by the great Commotions that have happen'd upon its Surface : And on the other hand, that all the Liquors we are acquainted with, that are al-

most Sulphurous like the Blood, acquire a lively redness, when they're mix'd with Salts not unlike to those contain'd in the Air. Thus all Liquors that contain Acid Salts, give a red Colour to the Tinctures, of Roses, of Violets, of Turn-sol, &c. notwithstanding that both the Liquors impregnated with these Salts, and the Tinctures extracted from these Sulphureous Plants, are of a quite different Colour from red before their mixture. Upon this Supposition, we may fairly conclude, that the mixing of some parts of the Air with the Blood, gives its Particles a new turn, and ranges 'em in a different way ; and perhaps its Salts being stiff and long parts, entitle the Blood to a readier spring ; so that when the Light falls upon the Surface of the Blood, it is reflected much more speedily ; and that is sufficient to excite in us the sense of a more rutilant redness.

When the Blood is drawn forth from the Veins, the Air makes such various Alterations upon it, according to the greater or lesser quantity of the Nitrous Salt that it communicates, that 'tis very hard to form a just Judgment of the Colour and Consistency of that Liquor, after it is cold. A certain Physician order'd a great Hole to be made in a Vein, and the Blood to be receiv'd in deep hollow Vessels, which were made warm, and not to be expos'd to the cold Air. After some time he return'd, and cry'd out, *It was bad Blood.* But this Gentleman would have alter'd his Thoughts, had he known, that the apparent badness of the Blood, proceeded from its being kept up from the Air, and from partaking of its Nitrous Salts. The great Gash in the Vein was a ridiculous Precaution, for any Orifice is larger than the Capillary Vessels, and yet the grossest Blood passes through them. So that a small O-

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rifice will give vent to as much gross Blood, as a great one. How comes it then, you'll say, that the Blood seems more corrupt, when the Orifice is large? Why, 'tis because the large Orifice voids a greater quantity at a time, and by that means the Air do's not mix so well with every Particle of Blood, nor impart so many Nitrous Salts. Besides, the warm Air being supply'd with fewer Nitrous Salts than the cold, must needs make the Blood appear more corrupt. In fine, the deep hollow Vessels do not expose so many Particles of Blood to the Air, as the flat ones. This Thought is back'd by two Experiments; the first of which is, that the little Drops of Blood falling upon the Brim or Sides of the Vessel, are always of a bright red Colour, the Air having a free access to their smallest Particles; and the Blood at the bottom of the Vessel, which the Air cannot penetrate, is always black.

Descartes alledges, That the Blood which was turn'd into Steams in the Ventricles, is condensed in the Lungs, and by virtue of the closer union of its Parts, is reduc'd to Drops. For that Author was of Opinion, that the Coldness of the Air, acts the same part, with reference to this Vapour, that the Lid of a Pot do's to the Steams that ascend. 'Tis for that Reason, says the Philosopher, that we are apt to faint, when the Air is too hot, or too subtile, since it makes too great a dissipation of the Spirits. I own, this Thought is subtile, but it supposes Falshoods, or at least Improbabilities. For, 1. I have prov'd, That the Blood is not reduc'd into a Vapour in the Ventricles. 2. Were the Blood so rarified in the right Ventricle, it wou'd be equally so in the left; and there would be a necessity of another Pair of Lungs to condensate the Blood. In fine,

since this System is only an Appendage of that of the Heart, the one being false, the other is not to be allow'd of. As for his Account of Swoonings, in too hot, or too subtile Air, 'tis sufficient to reply, That these are better accounted for by another Hypothesis, *viz.* That we fall into Swoonings, when the Circulation is interrupted ; which happens when the Lungs are not sufficiently blown up : Now when the Air is too thin, instead of swelling the Lungs, it slips thro' its Pores. But this is not the only Reason of Swoonings on that occasion ; for when the gross Air forsakes our Body, the Liquors and Spirits have no Barrier to hem them in ; so that they fly away, and the Body being left unprovided, falls into Swoons.

I shall not here touch upon the Use of the Lungs in the *Fetus*, nor offer any Reasons, why its Blood, tho' mix'd with little Air, is red, and entitled to a Spring : All these Phœnomena shall be explained at large, when I come to treat of the Nourishment of the Infant in the Womb.

Since the Respiration of some Animals differs much from that in Man, 'twill be equally instructive and diverting, to enquire how the Air communicates its Nitrous Salts to their Blood, and gives it the red Colour and Spring, and promotes its Circulation.

Most Fishes are destitute of Lungs. They have not the four great Vessels at the Basis of the Heart ; but only two, with one Ventricle, which receives the Blood from one of these Vessels, and throws it out into the other. That which receives the Blood from the Heart, which we may call their *Aorta*, is divided into several Branches, each of which rests on a little bony Circle.

Circle. And these make what we call the Gills of Fishes. After that, each of these Branches is subdivided into little Twigs, which run to what we call the Beards of the Gills; and then the different Branches re-unite, and form another Trunk of an *Aorta*, which is again divided, and sends one Branch to the Head, and another to the rest of the Body. This perhaps is the manner of Respiration, that differs most from ours. The Water, and the Particles of the Air lodg'd in it, which continually pass and repass in their Gills, cannot but insinuate into their *Aorta*, and by consequence to the Blood, the Nitrous Salts they contain. Besides the pressure of the Water upon the Gills, may promote the Circulation: And perhaps, the Air it self that goes along with the Water, penetrates into the Vessels.

In most Fowls the Lungs are immovable, and neither swell nor sink, notwithstanding that the Air rushes in and out. These Lungs have seven or eight Holes, which answer on one side to the Branches of the Windpipe, and on the other side to the large Membranous Bags, which are fill'd with Air in the Inspiration, and expelled again when they are squeez'd by a particular Skin: So that the Lungs which are fastned to the Ribs, seem only to serve for a passage. To understand how the Air passing and repassing in the Lungs of Fowls, communicates to the Blood some of its Particles, you must know, that all the Holes in the Windpipe do not open upon the Membranous Bags; for there are others in a manner unperceivable, which have communication with the Vesicular Cells of their Lungs. This may be made to appear from their lightness; for their Flesh floats in Water, which is evidence that it is full of Air. This Air is insensibly renew'd, as well as that of the Vesicular Cells in Men. The

office of the Membranous Bags is the same with that of our Middriff, in pressing and squeezing, by repeated Thrusts, the Bowels of the Abdomen: But their greatest use consists in containing and supplying a great quantity of Air, to make them long-winded when they sing.

T A B. V.

Representing the Situation of the Vessels, and Lobes of the Lungs.

Fig. 1. From Willis.

- a a. *One Lobe of the Lungs cut up.*
- b. *The Trunk of the Pulmonary Artery.*
- c. *A Branch of it cut.*
- d d. *The Ends of some Branches cut open.*
- ee. *Its small Branches, which make the Net round the Vesicles.*
- gg. *The Branches of the Trachæa*

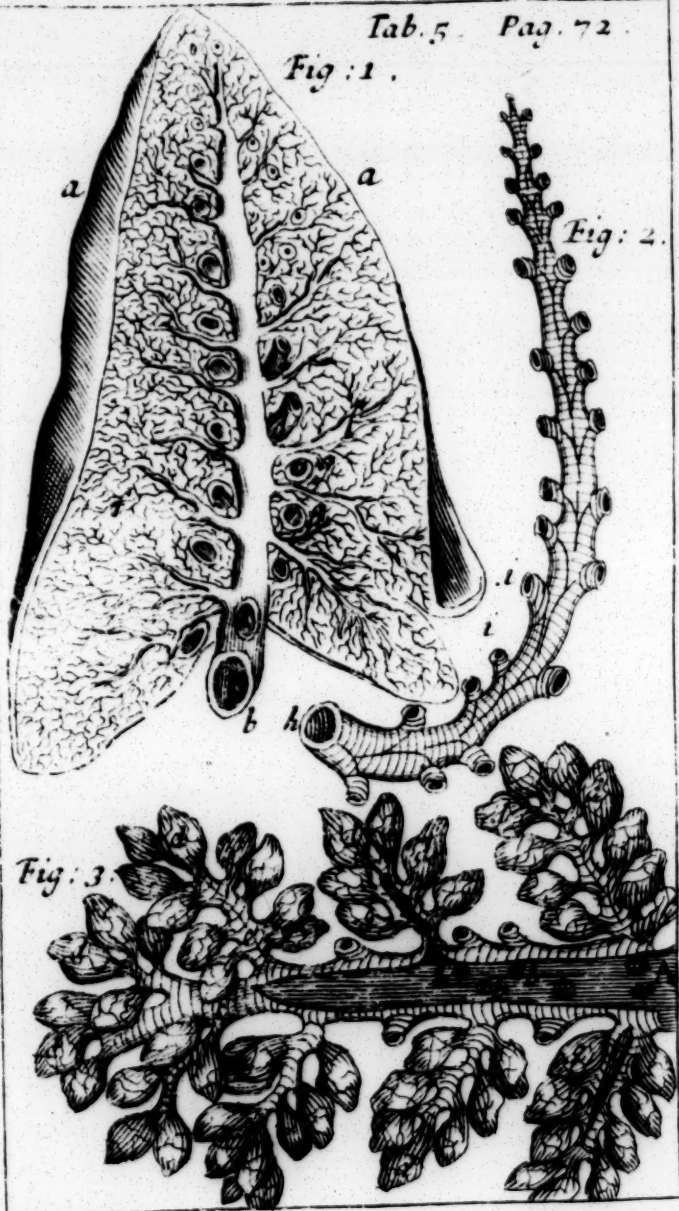
Fig. 2.

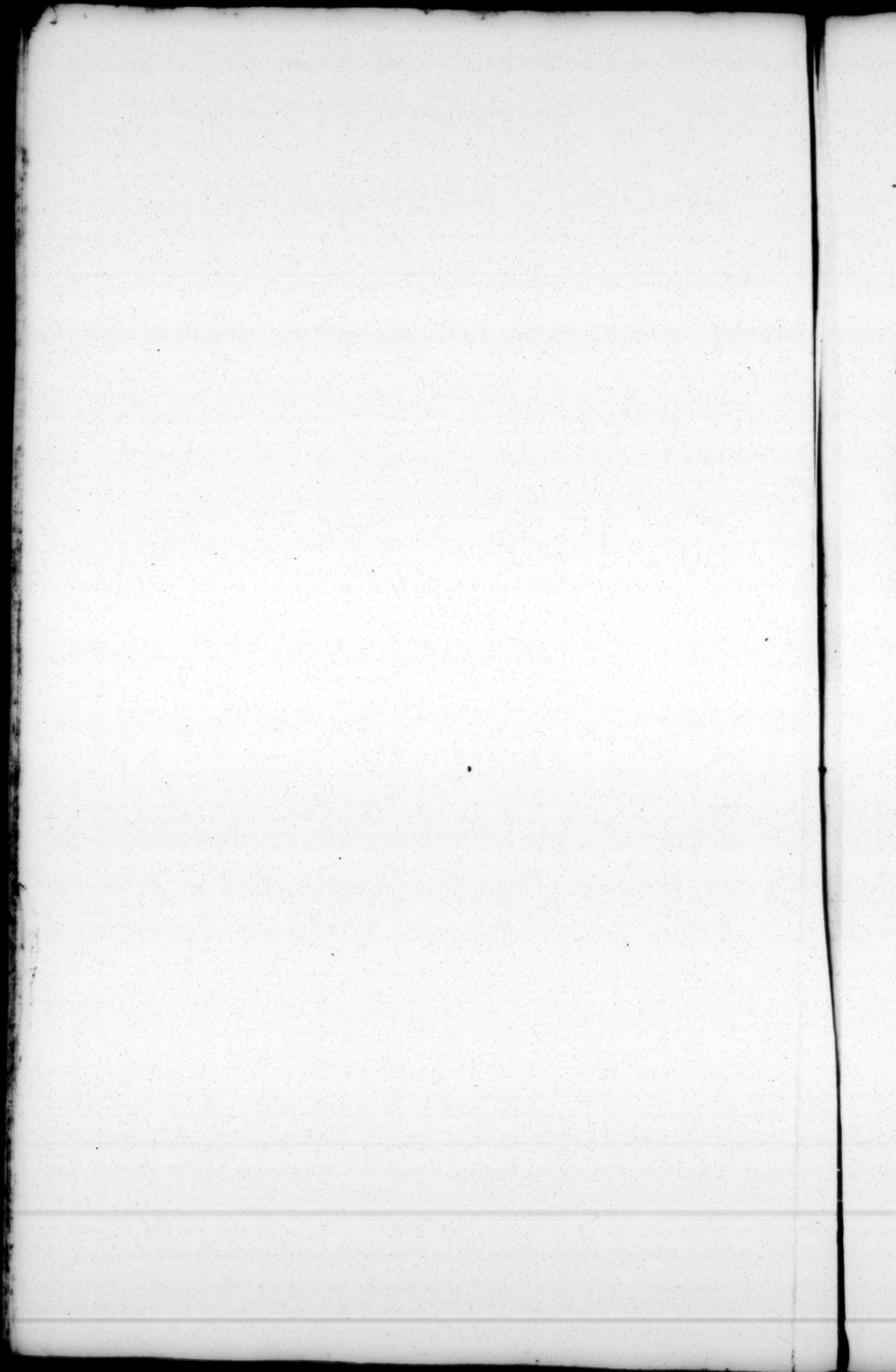
- h h. *The Trunk of the Windpipe.*
- ii. *Its Branches.*

Fig. 3.

- A. *The Trachæa laid open.*
- b. *The Orifices of its Branches*
- c. *Its Cartilages.*
- d. *The Secondary Lobes.*

Fig: 1.





C H A P. VII.

Of the Refining and Filtration of the Blood.

TH O' the Chyle has been subtiliz'd by its Fermentation in the Ventricle and small Guts, and by the impulse of the Diaphragm and Muscles of the Abdomen, &c. it is not yet arrived at the last degree of Subtility and Motion, that is necessary to turn it into Blood. It meets with a fresh pressure in the Ventricles of the Heart, the Lungs, and the Arteries: And 'tis by that means, that its parts are so rang'd and mov'd, as to entitle it to an equal heat, redness, and liquidness with the Blood: For, besides that it is attenuated and put into a strong motion by all these different pressures, 'tis likewise mix'd with the spirituous parts, that it receives from the Air of the Nerves, Lymph, and Blood itself: But even in this Condition, it stands in need of many other Filtrations and Refinings, in order to be qualified for the Nourishment of the parts.

The Blood sets out from the right Ventricle, and visits all the parts of the Body through the *Aorta*; and the spring, or rebound of the parts repulses it to the right Ventricle of the Heart by the *Vena Cava*. But before we dip further into this matter, I reckon, 'twill be proper to explain how the *Aorta* is able to drive the Blood into the remotest parts.

Willis alledges, that the Arteries have four Membranes; the first, or innermost of which, consists of a Contexture of Vessels; the second,

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of a Quantity of Glandules; the third, of Fibres; the fourth, and outermost, is Nervous. Then he pretends to explain the motion of the Arteries, by the contraction of their Muscular Fibres. But forasmuch as it is certain, that the parts he describes, are not to be found; and that several Experiments give us to know, that the motion of the Arteries do's not depend upon the Nerves, we have all Reason to depart from his Opinion.

'Tis easie to prove, that the Arteries are of a Cartilaginous Substance, since they often become bony; and that they have a great spring and rebound; so that when they are dilated by the Blood departing from the Heart, they retrieve their former state by the force of their spring, and squeeze out into the Veins a quantity of Blood, proportional to that they receive from the Heart: And it is for that Reason, that the Blood springing out of a wounded Artery, has not a continu'd, but an interrupted motion.

The *Aorta*, or great Artery, drives the Blood into all the parts of the Body. 'Tis continuous to the left Ventricle, which possesses a much greater number of fleshy Fibres than the right Ventricle: It has a Substance much stronger, more cartilaginous, and more proper for making a rebound, than the Artery of the Lungs, which rises out of the left Ventricle, and go's no further than the Lungs.

The Fabrick of a Vein is quite different from that of an Artery; so that *Willis* is mistaken in giving it the like Composure. A Vein is not at all cartilaginous; 'tis soft and membranous; it do's not beat; it has a great many Valves, which allow the Liquor to run from the parts to the Heart, and oppose its retreat from the Heart to the parts. And on the contrary, there is not
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one Valve to be met with in all the Arteries, unless it be at their entrance into the Ventricles of the Heart.

There is no difficulty in giving a Reason, why the Veins don't beat as well as the Arteries: For the Pulsation of the Arteries, is only occasion'd by their receiving the Blood immediately from the Heart, and that with Violence, and by Jerks; and by their strong Spring, which contracts them when the Current of the Blood is broke. But when the Blood passes out of the Artery into the Vein, it spends its motion in dilating the fleshy Fibres, and so has none left to impart to the Vein. This is so constant a Truth, that when the Arteries empty themselves immediately into the *Sinus's* of the *Dura Mater*, they raise a Pulsation like to their own, tho' these *Sinus's* are altogether of the same Nature with the Veins; and when we transfuse Blood out of an Artery into a Vein, the Vein beats; but then its Pulsations are quickly sunk, for it being softer, and its Spring much weaker than that of an Artery, it loses, on its way, the motion it had receiv'd.

The Blood in the Veins differs from that in the Arteries, not only by its Motion, but likewise by its Colour and Consistency. The same Blood that in the Arteries is fine, and of a bright colour, becomes blackish and gross in the Veins. Questionless, so great a *Metamorphosis* can never be brought about, without its staying some time in the parts. Then indeed, being lodg'd in a place where the Air has no action, it loses the Qualities it receiv'd from the Lungs. Besides, 'tis stripp'd of some of its most refined parts, which the Arteries drive into the Fibres of the Membranes, or into the Glandules, and are from thence convey'd to the particular passages: If they fall
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in with the *Conglobate Glandules*, they repair to the Lymphatick Vessels; if they are driven upon the *Conglomerate Glandules*, they pass into the Pipes peculiar to those Glandules.

The *Filtration* of this Lymph in the Glandules or Membranes, is occasion'd by their close Contexture, which is only qualified to give passage to the most refin'd, disengag'd, and watery parts of the Blood. The Vessels that spring out of the Membranes and *Conglobate Glandules*, are call'd *Lymphatick Vessels*. They either open into the Veins, or else are gathered into Trunks, which run into the *Cistern of the Chyle*: For instance, those of the Thighs form a Trunk, which, after its arrival in the Abdomen, is term'd *Iliack*; those of the Liver, the Spleen, &c. re-unite, and form the *Hepatick Trunk*; and those of the *Mesentery* and *Intestines*, produce the *Mesenterick Trunk*; and all the three empty themselves in the *Cistern of the Chyle*: those of the Breast do, all of 'em, run into the *Thoracick Duct*; those of the Arm, into the *Axillary Vein*; and those of the Head, into the *Jugulary*, or *Subclavian Veins*.

All these Lymphatick Vessels disappear, when the Animal dies. During its Life, two Experiments may be made, which will absolutely overturn the System of those who pretend, that the Lymph runs from the Center to the Circumference. The first is made, by tying these Vessels, upon which they will swell extreamly between the external Parts and the Ligature, and sink from the Ligature to the Heart. The second is made by blowing into them, for the Wind will pass with ease from the Extremity to the Heart, but will not go from the Heart to the external Parts, by reason of their Suckers, or Valves, which are plac'd the same way as in the Veins.

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The Lymph congeals easily, and is a little unctuous ; so that one may say with *Bartholin*, that it is a simple Water, resulting from the Nourishment of the Parts. *Glisson* thought it was the product of the Vapours of Blood condensed into a Nervous Juice ; but besides that the *Hypothesis* of the Nervous Juice is Chimerical, it is demonstrable, that these Vapours may indeed be turn'd into Water ; but that this Water will never turn into a Jelly, as the Lymph does. In fine, the separation of the Vapours from the Liquor, will require a void space ; now there is no such space in the Glands, in which the Lymph is separated from the Blood : And there is far less in the Membranes ; for the Pores of all these Parts are very narrow and compact.

Some have alledg'd, that this Lymph is the residue of the Animal Spirits, or the Nervous Juice ; but they are likewise mistaken : For so subtile a Liquor as the Animal Spirits (if there were any such), which, upon the least Nod of our Will, sallies out with incredible swiftness through invisible passages, from one end of the Body to the other ; such a Liquor as this cou'd never form a gross Liquor, that wou'd turn into a Jelly. Besides the parts that have fewest Nerves, and are least sensible, *viz.* the Glandules, produce most of that Liquor. And this one Reason might serve to overthrow the System of the Nervous Juice : But I reserve that Task for another place.

We conclude therefore, that the Lymph is a Liquor separated in the Membranes and Glandules, and compos'd of Volatile Salts and Sulphurs, which render it apt to congeal. When this Liquor is mingled with the Blood, it serves to keep up an exact mixture among the parts of the Blood that are of different sizes : For 'tis
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manifest, that the difference of Bulk and Figure, will dispose the Parts of the Blood to a separation. Besides, the difference of weight will oppose an exact mixture. 'Tis true, the Circular Motion is able to re-unite what the Motion of weight endeavours to sever. But since this Circulation gives a greater Motion to some parts of the Blood than to others, according to the difference of their Figure, or Bulk, or Solidity; it is a necessary consequence, that these various parts will have a tendency to separation, pursuant to the diversity of their Motions. Indeed, one of the chief things that may contribute to keep up the mixture and union of these different parts, is, that the coarsest parts are not simply mix'd with the smallest, but there are a great many gradual Differences, descending towards the smallest, by little and little; for instance: Suppose 100 Degrees of different Magnitude among the parts of the Blood, the highest can never be mix'd with the lowest, without the intervention of the 98 Degrees of the other parts; the first of which will easily unite with the 2d, as the 99th will with the 100th. This may be made out by several Experiments in mixing of Liquors; Hog's-grease, for example, will never mix with Water: But the addition of Oyl, and some Salts, will make a good mixture. This premis'd, I affirm, that the Lymph is the uniting Medium between the Serous and Fibrous Parts of the Blood; its Parts being neither so small as those of the one, nor so large as those of the other. It serves also for Nourishment to all Bony and Membranous Parts: For since the Blood nourishes all the different Parts of the Body, it must needs contain Particles of various Bulk and Figure, to be rang'd in the different Pores of the Parts: And that the Lymph is the principal
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Nourishment of the Bony and Membranous Parts, is made to appear, by breaking or cutting a Cartilage or Tendon, for then they void a sort of *Lymphatick Liquor*, that quickly turns to a Jelly. The *Lymph* is easily distinguish'd from the *Serum*, if we observe that neither Heat nor Cold will turn the *Serum* into a Jelly : But on the contrary, both the one and the other will readily make the Lymph congeal ; besides, that the Lymph tastes sweet and fat, and the *Serum* is sharp or saltish. In the mean time, both the one and the other, are separated from the Arterious Blood, but by very different Strainers.

Tho' these two Liquors differ almost in every thing, they serve nevertheless some times for the same Uses ; for while they're mix'd with the Chyle, both of 'em serve to dilute its Parts, and render it fluid. The Lymphatick Vessels empty themselves in the Cistern of the Chyle, or in the Veins : But it happens sometimes, that the Veins are stopp'd up, and the Lymph curdles in its Vessels, because they cannot disburthen themselves. Mr. *Du Vernay*, Surgeon in *Paris*, shew'd me this in the Livers of two Hydropick Persons, where we found, that the *Lymphatick Vessels* were full of a clammy Matter, and resembled a String of Beads.

The Lymph and Serum are not the only Liquors that are strain'd out of the Blood. There are some Secretory Sieves in the Body, that strain out an Oily Liquor, which by lying some time in the Membranes between the Flesh, is turn'd into fat ; or else, by continuing in the Cells of the Bones, is converted into Marrow. Most Membranes have Bags fit to amass a great quantity of this Oily Matter ; and Pores of such a configuration, that they give it an easie passage
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from the Arteries into the Cells ; where, as soon as its motion is gone, its hooked Parts engage within one another, and render the Liquor thicker : And the more Cells there are in the fat Membranes, or in the Bones, the more Fat, or Marrow, may be gather'd. And by reason that the *Caul* contains a great many of these Cells, some Authors have taken it for the Original Seat of the Oily Humour, which they made to be deriv'd from thence, to all the Parts, by peculiar Vessels, that they call'd *Adiposa* : And, what favours their Opinion, we find Beds of Fat commonly following the Course of Veins, and sending out Branches along with theirs. But if we consider, that most of these pretended Fat Vessels have no communication with the Caul ; and that the Oily Liquor is fix'd in these Beds, we will easily be convinc'd, that the Caul is not employ'd for that use. It has no distinguishing Character, with reference to the other Coats of Fat, but that of its Situation. In earnest, it is nothing else but a double Membrane fill'd with Cells ; furnish'd with a number of Arteries from the *Coeliaca*, and Veins that run into the *Vena Portæ*, and several Nerves that spring from the Eighth Pair, together with a great many Lymphatick Vessels. It is ty'd fast to the Stomach, the Spleen, and the Gut *Colon*, and covers the Intestines.

This Part therefore hath nothing but its Situation, that is not calculated for the Fat. The Caul, and the other Bags of Fat, receive an Oily Liquor, which fixes there by the loss of its Motion, and by virtue of some Acid Spirit : For Dr. *Grew* made a perfect Resemblance of this Substance, by boiling *Spirit of Nitre* with *Oyl of Olives*.

It may be ask'd, Why the Acid Spirit does not congeal this Liquor in the Mass of Blood ? I answer, 1. That the Sulphureous Parts being over-exalted by the Motion of the Blood, keep the Spirit under. 2. The other Humours contain'd in the Vessels, hinder it to mix exactly with the Oily Parts.

The Uses of this Oily Liquor are manifold : 1. It supple the Bones, Cartilages, and Ligaments, and renders 'em less apt to break. 2. It tempers the sharp and corrosive Humours. 3. It mitigates the Impetuosity of the Blood, by its hook'd and intangling Parts, which fetter the subtle and active Particles.

Upon this Principle we may easily explain how it comes to pass, that the Cartilaginous Parts harden, and turn bony, when this Humour is deficient : As it usually happens to old People, they being unprovided of this Oily Juice ; and for the same Reason they are subject to Defluxions, Catarrhs, Rheumatisms, &c. for the sharp Particles being then at liberty to exert their force, do twitch, corrode, and unrip the Membranes, or else fix the Fibrous Part, and separate it from the *Serum*. That I take to be the Source of the above-mention'd Maladies : And, which is worst of all, they are incurable in old People, for want of a sufficient quantity of the Oily Liquor, to master the sharp corrosive Particles, and to reunite the Fibrous and Serous Parts. This Principle will likewise furnish us with a Reason, why fat People have usually less Appetite than others : for their sharp Humours being more kept under by this Oily Humour, act with less force upon the Stomach. That this Humour retards the Motion of the Blood and Humours, is plain from the slower Pulse of fat Persons. 'Tis no wonder, that Fevers, or eating little, shou'd

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make People lean ; for the Circulation being then more rapid, the Blood sucks the Oily Humours out of their Cells. And upon that account, 'tis believ'd, with some likelihood, that the Fat turns into Nourishment ; for the Animals, which lay up a great deal of Fat in Summer, eat very little in Winter ; and the Tortoises, for instance, have particular Cisterns full of Fat near the Intestines ; the first of which is remitted to the Mass of Blood, to recruit what's lost by dissipation.

From what has been said, we may conclude further, that when the Bones are harden'd by sharp Humours, and render'd less pliable for want of Oyl, they're very apt to break ; and accordingly we find the Bones of Old People, are at once very hard, and very brittle : And sometimes their Tendons and Arteries, and the *Sigmoides Valves*, are all ossified.

A further use of this Oyl, is to detain the subtile Particles, by intangling them amongst its own ; and even when it is laid up into Coats of Fat, to stop the Passages through which they might get out, and keep out the Cold : So that it serves for a Furr, or Covering ; and accordingly, we see, fat People are not so chilly as those who are meagre.

C H A P. VIII.

Of the Change which the Blood undergoes in the Pancreas and Spleen.

THE Course of the Blood is not unlike that of Waters impregnated with Salts, which, by Watering some Grounds, change their Nature. In its progress through the Parts of the Body, it acquires sometimes a greater, and sometimes a lesser degree of swiftness; and in some places it even changes its first form, whether it be that some Portion of Blood is separated from it, or that it receives some fresh Matter in the Secretory Sieves, or that the Disposition of their Pores alters the Figure of its Particles. This is what we call the *Modification*, or *Alteration* of the Blood in the Bowels, particularly in the *Sweet-bread*, and *Spleen*.

One would think, that there's nothing very remarkable in the passage of the Blood through the Spleen; but after we have examin'd its Structure, it will plainly appear, that the Blood is subtilized there, in a distinguishing manner.

The Spleen is a soft and spongy Body, seated in the left *Hypochondrium*, under the *Middriff*, near the *Caul*, the Gut *Colon*, and the left Kidney. There is usually but one Spleen; but sometimes, as *Fallopins* has observ'd, we meet with two or three. Its Figure and Bulk are so uncertain, that it cannot be determin'd in general; for in some it is triangular, in others square; in some round, in others long; in some thick, in others thin; in some large, in others small, &c.

'Tis cover'd with two Tunics, the uttermost of which is a production of the *Peritoneum*, being deck'd with a number of Vessels, and some Filaments, by which it is ty'd to the inner Coat : And, what is most remarkable, the Lymphatick Vessels creep along this Membrane, and afterwards re-unite, and empty themselves in the Cistern of the Chyle, having past over the *Caul*.

Upon the removal of the outer Coat, we discover the inner one, which is interlaced with different Rows of Fibres, that intersect one another in a wonderful manner. This Coat is so thick, solid, and hard, that it is sometimes bony, and often tendonous : It extends it self into the substance of the Spleen, and forms a *Capsula*, or Case, that surrounds the Vessels during their whole progress.

In the Spleen we perceive some Fibres rising out of one of the sides of the inner Membrane, most of which run transverse-ways, to the opposite side of that Membrane, and some of 'em terminate in the *Capsula*. These small Fibres, are compos'd of lesser Fibres, and may be justly call'd Muscular, since the Membrane in which they terminate, is so Tendonous, that it often becomes Cartilaginous and Bony.

Here we find a Vein and Artery, and two Strings of Nerves, wrap'd up in one Case, which are branch'd out through the whole Body of the Spleen. The Artery is deriv'd from the *Cœliaca*, the Vein runs into the *Vena Portæ*, and the Nerves rise out of the Eighth Pair. The substance of this Bowel is all over Membranous, and divided into several little Cells which are lodg'd between the production of the Vein, and its Trunk. These Cells have a mutual communication, and unload the Blood they contain, not
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only in the Branches, but likewise into the Trunk of the Veinous Pipe. They are fasten'd to the Fibres that run a-cross the Body of the Spleen, and it is very likely, that the little white Points, which are to be seen in the Cells, are the Tendons of these Fibres, and not Glandules, as *Malpighi* thought. These little Bags are form'd by the inner Membrane.

Having view'd the Structure of the Spleen, we come now to unfold its principal Uses, and to trace the Cause of all the Accidents, that befall a Dog whose Spleen is cut out. The Spleen contains, 1. A Quantity of fleshy Fibres. 2 Nerves and Tendons. 3. Cells in which the Veins and Arteries terminate. 4. When we syringe the Artery, the Blood passes easily through the Vein, which does not hold in other Muscular Parts, where a great deal of force is requir'd, to make the Blood pass from the Artery to the Veins. This Bowel may be taken out of an Animal, without killing it. But then the Consequences will be these: 1. It will be more gay and cliver than usually. 2. It will eat more, and vomit often. 3. After its Death, the Liver is found thicker than usually, and so dry'd, that it may be easily broken into small pieces.

There seems to be no Filtration perform'd in the Spleen, unless it be in its outer Membrane; for it enjoys no Excretory Vessels, bating the Lymphaticks, which are plac'd in that Membrane: So that it cannot exalt and subtilize the Blood, unless it be by adding to it some subtil Matter, or by imparting to it some particular Motion, as I said of the Lungs. Now the manner, in which I take that to be perform'd in the Spleen, is as follows.

When the Arteries have thrown the Blood into the Cells, if the Fibres of that Bowel be remov'd one from another, they'll retrieve their Natural State, by Virtue of their Spring; and by that means the Cells will be squeez'd, and the Matter contain'd within 'em be ground, and render'd more subtile: And perhaps the very Matter that swell'd the fleshy Fibres, will mix with the Blood. We may imagine, that the Animal Spirits, which perhaps occasion'd the swelling of the Fibres, join in with the Blood; which upon its departure out of the Cells, ceases to block up the Pores of the Fibres. But let it be as it will, it is probable that the Matter which swells the Fibres, makes its exit along with the Blood; since the Blood by unstopping the Pores of the Fibres, gives it leave to slip out. 'Tis not upon those Reasons only, that I take the Blood of the Spleen to be more subtile; but likewise upon this account, that the Blood of the Arteries passes immediately into the Veins, without losing much of its Motion, or continuing long in that part.

This exalted Blood communicates some subtile Parts to the Bile, which increases its Motion; whence it follows, that it makes less impression on the Parts through which it passes, because it makes but a little stay in 'em. And so the Bile not being corrected in an Animal, from whom the Spleen has been taken, it corrodes and dries up the Liver. It increases the Appetite, and sometimes occasions Vomitings, by fretting the Stomach and Intestines. By making the Chyle more sharp, it excites Fermentations in the Blood, which furnish more Matter to put the Body in Motion. Besides all those Uses, the Spleen, like the other membranous and glandulous parts, contributes to the Filtration of the Lymph.

Having

Having given this Opinion of the use of the Spleen, I come to examine the Sentiments of others. Some Moderns pretend, that it furnishes the Blood with Animal Spirits which mix themselves with it, and serve to precipitate the Bile into the Liver. But this Opinion is not probable : For it is not at all necessary, that the Bile should be precipitate, since its Filtration can easily be explain'd by the very disposition of the Pores. There is a considerable space requir'd in a Vessel wherein a Liquor is to be precipitated, and that of the Capillary Branches of the *Porta*, do's not seem to be sufficient for it. But that which absolutely overturns this System, is, that the Blood being like Milk, the Spleen must furnish an Acid for precipitating of it ; and this separation of the subtile Parts from the gross, must every Minute occasion fresh Obstructions.

Some other Moderns suppose, that there is an acid Leaven in the Spleen, which contributes to the separation, and likewise to the formation of the Bile. The Blood, say they, by continuing in it for some time, grows sour, because it passes from the Artery to the Cells of the Spleen, which are very large. This Opinion, which is very common, does plainly shew, that Men have now their recourse to Ferments, as they had formerly to occult Qualities. For if you ask of those who maintain this Opinion, what makes the Blood to turn into a Bone, they will answer that, that change is made by an ossifick Ferment, as they pretend that in other parts there are stony and fleshy Ferments to be found. If the Blood become sour in the Spleen, it must grow thick ; and so instead of serving to separate the Bile, it wou'd hinder its separation. Besides, the Circulation is not less slow in the Spleen, than in the other parts ; because when it is once fill'd, if the

Blood which goes out of the Artery, enters into a wider space, that which goes from the Spleen to the Vein, enters into a narrower; and consequently it has the same swiftness, as if it ran in a Canal which were all along of the same Diameter; so that it cannot become four in the short time of its stay there.

The ancient Physicians believ'd, that the Spleen was the Seat and Receptacle of the melancholy Humour: Being of Opinion, that the Mass of Blood was made up of the four Humours, they allotted a particular Mansion for every one of the Humours; the Brain, according to them, was the Seat of the Flegm, the Gall-Bladder that of the Bile; the Spleen was the place of Melancholy, and the Kidneys made a Secretion of the Serous Humours.

These were the four Cisterns of the excrementitious Humours: But they were puzzl'd to find excretory Vessels for the Brain and the Spleen: Nevertheless, they fancied that the Brain unloaded it self by the Holes of the *Os Cribrosum*, and by those of the *Sella* of the *Sphenoides*; and that the Spleen throws out, sometimes by the Hemorrhoid Veins, and sometimes by the *Vas Breve*, a sharp Humour, which helps the Appetite, and assists Digestion. Which Opinion they confirm from this, that those who are subject to Melancholy, are eas'd by the running of the Hemorrhoid Veins, and have always a good Appetite.

To refute all the Errors of this System, would oblige me to straggle too far from my Subject; I shall only observe, that no such Humour is to be found in the Spleen, and that the Blood which it contains, has such a Quality, because the Air has made no Impression upon it. We must know besides, that the Spleen cannot discharge

charge it self into the Hemorrhoid Veins, both because of the Laws of Circulation, and likewise by reason of the Valves which oppose it: And it is likewise for these two Reasons that it cannot discharge by the *Vas Breve*. As to their Allegation, That the running of the Hemorrhoid Veins, gives ease to those that are Splenetick, I answer, That since the Hemorrhoid Veins do not then empty themselves into the Branches of the Spleen, they leave a greater space in that Vessel, and give it the more freedom to unload it self. And if those that are Splenetick have a better Appetite, the Reason is, because their Blood is sharper, and so a more whetting Juice is filtrated into their Stomach, but that is not to be suppos'd to come from the Spleen. I cannot conceive upon what Principle it has been thought, that the Spleen causes Laughter, and that it communicates a spirituous and agreeable substance to the Heart. These are things that have been establish'd without proof, and cannot be believ'd without prejudice.

As the Blood receives a Sublimation in the Spleen, so that which passes thro' all the other Parts of the lower Belly, becomes more gross: For it leaves a great many volatile and fluid Parts in the Ventricle, in the Glands of the Intestines, and in the *Pancreas*, which is like one of the Salivary Glands, and empties it self in the Intestines.

The *Pancreas* is a soft, crumbly, whitish Body, compos'd of a number of little Glandules, cover'd with one Membrane, and plac'd under the *Ventricle*, between the Liver and the Spleen. 'Tis usually seven or eight Fingers in length, and one in breadth; and is a little thicker towards the *Duodenum*, than towards the *Spleen*. Several Vessels are to be seen in it, such as Veins, Arteries,

teries, Nerves, and Excretory Pipes. The Arteries come from the *Celiacæ*, the Veins reach to the *Porta*, the Nerves come from the first *Plexus* of the *Abdomen*, and all the Excretory Vessels terminate in a Trunk which passes to the *Duodenum*; sometimes it opens into the *Ductus Cholidochus*.

Tho' in speaking of the Salivary Glands, I have examin'd something of the Nature and Differences of conglobate and conglomerate Glands; yet having only done it by the bye, it may not be amiss to speak a little further of 'em here.

The conglobate Glands have a pretty smooth round Surface; they ordinarily give rise to the Lymphatick Vessels. Some Anatomists have thought, that they have no hand in the Filtration of the Lymph, because it seems, that the Lymphatick Vessels do only cross 'em, and take their rise at a greater distance.

The conglomerate Glands are compos'd of a great number of other little ones, and have particular Excretory Vessels. The *Pancreas* is look'd upon as a conglomerate Gland. We are likewise to conceive every little Gland, either as a Sponge, which has different Holes, some of which do reach from the Artery to the Vein, and the rest from the Artery to the Excretory Conduit; or as an Arterial Vessel folded back, some of whose Branches meeting together, make up one of the Branches of the Vein, and the rest one of the Excretory Vessels. The Blood passes from the Artery into the Vein, because the Holes, or Passages of Communication between the one and the other, are large enough to give way to it; but they cannot get into the Holes of Communication, which are between the Artery and the Excretory Vessels; either because their Figure is only fit to receive such an Humour as the Pancreatick

atrick Juice ; or rather, because they are too narrow to let in a Liquor of that grossness. To every little Gland, there is join'd a Branch of an Artery, of a Nerve, of a Vein, and an Excretory Pipe.

Their Structure being thus known, it is easie to conclude, that of the Blood which is carried by the Artery into the Gland, no more can pass through the Pores corresponding with the Excretory Pipe, than the Parts which are proportion'd to them ; that is to say, the Pancreatick Juice ; and that the rest passes into the Vein : But the long Windings of the Vessels that make up the Gland, serve for a double use : 1. They subtilize the Humours, because endeavouring to go in a right Line, they dash themselves against the Corners of the Vessels which they are oblig'd to pass, and split themselves by jostling against one another. 2. The separation of the different Liquors is facilitated by the many Circumvolutions of the Vessels ; both in regard to their smallness, which obliges the Particles of Blood to pass one by one ; and by reason of the nice separation of the most fluid and movable Parts, from those which possess most of Earth ; such a Separation being unavoidable in so narrow and long a passage.

The Juice which is separated from the Blood in the *Pancreas*, passes thro' *Virfungs*'s Duct, into the *Duodenum*. Some think that it is Acid ; and upon the famous Principle of Acid and Alkali pretend, that this Juice ferments with the Bile, which is fill'd with *Lixivious Salts*. But those who are most fond of this Opinion, (I mean *Silvius*'s Votaries) are obliged to acknowledge, that it is often insipid, and commonly a little harsh or saltish ; and in effect, when it is acid, the Animal is always disorder'd. The use
of

of this Juice, is to render the Chyle more fluid, to separate the Salt from the Bile, and so to temper its Violence. Besides, it serves to separate the gross Parts of the Chyle from the subtile Parts. And as it operates principally upon the Chyle, so it never runs out but when the Chyle enters into the Intestines: For as we have said already, (*Chap. 5.*) when the Ventricle has been strongly swell'd by the Fermentation that the Aliment undergo's, and has squeez'd the Cisterns of the Bile, and Pancreatick Juice, it contracts it self, and drives the Chyle into the Intestines, where the Chyle cannot miss of meeting these two Liquors, since their Cisterns were squeez'd but a Minute before.

T A B. VI.

Representing the Spleen, and the Pancreas.

Fig. 1. From *Ruyfch.*

- a. *The Splenick Artery.*
- b. *The Vein.*
- c. *The Nerves.*
- d. *The Lymphatick Vessels.*
- e. *The Ligature.*
- f. *The Lymphatick Vessels spread along the outer Membrane.*

Fig. 2. From *Highmore.*

- a. *The Vena Porta.*
- b. *The Splenick Branch.*
- c. *A Valve.*

d. *The*

Fig: 3.



Fig: 1.

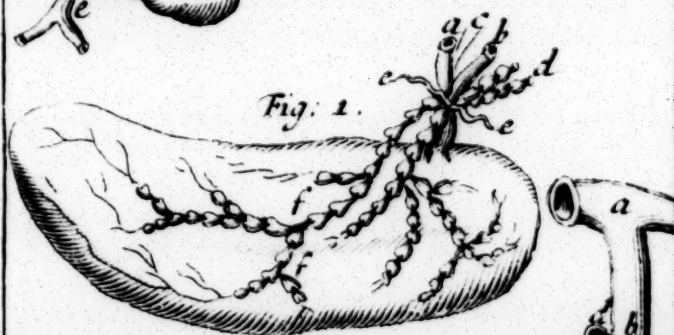
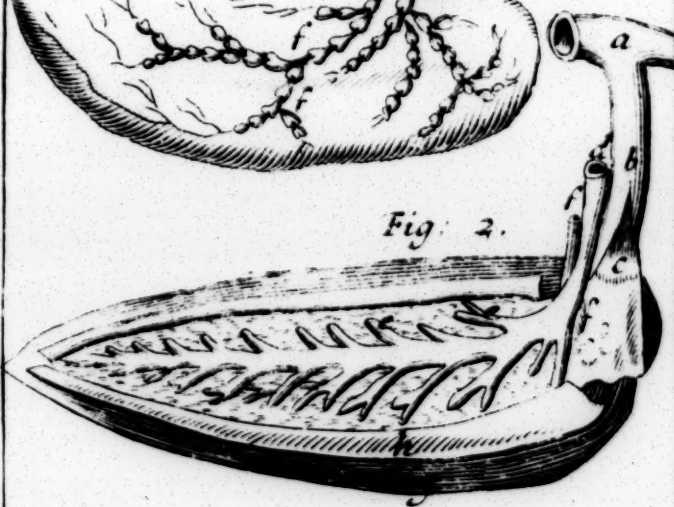


Fig: 2.





- d. *The Splenick Artery.*
- ee. *Its Branches.*
- ff. *Some Branches of the Nerves that accom-*
pany 'em.
- g. *The Spleen stripp'd of its outer Mem-*
brane.
- h. *The inner Coat turn'd up.*

Fig. 3:

Representing the Pancreas; and Virfungus's
Duct.

- aa. *The end of the Duodenum.*
- b. *The Pancreas.*
- c. *The Pancreatick passage.*
- dd. *Its lateral Branches.*
- e. *The Union of the Cystick and Hepatick pas-*
sages. which forms the Ductus Cholido-
chus.
- f. *The place where the Bile-pipe, and that of*
the Pancreatick Juice, terminate.

CHAP.

C H A P. IX.

Of the Filtration of the Bile.

WE ought to consider the Liver, as being a conglomerate Glandule, through which the Blood of the *Vena Porta* passes into the *Cava*: For when the *Porta* has receiv'd the Blood, that was convey'd by the Arteries into the Spleen, the Caul, the Mesentery, and the Intestines, it divides it self in the Liver into several Branches, and leaves there a sharp Juice, which we call the Bile; by which means the remainder of the Blood that enters the *Cava* has less Acrimony, not unlike the Sea-water, that in passing through Sands becomes sweet, by dropping a great part of its Salt.

In order to unfold the use of this part, and the way of filtrating the Bile, 'tis necessary to be acquainted with its Structure, in pursuance of the Method we have follow'd in explaining the Uses of all the other Parts of the Body.

The Liver is a thick Glandule, seated in the right Hypochondrium. 'Tis Convex towards the Middriff; and hollow towards the Ventricle. The Ancients made a distinction of four Lobes in it, which they call'd, *Porta*, *Mensa*, *Gladius*, and *Unguis*. Galen assign'd it five Lobes: But however it may be divided in Brutes, 'tis uniform in Men.

The Liver is suspended by three Ligaments: The first is call'd *Suspensorium*, which is broad and strong, and fastend to the Diaphragm, and the *Cartilago ensiformis*. 'Tis not only a produ-
ction

tion of the outer Membrane of the Liver ; but it penetrates so deep into the Substance of that Bowel, that it reaches even to the *Capsula* of the *Porta*. The second is narrow, but very strong, and suspends the Liver by its hindermost and left part, tying it to the Middriff. The third is the *Vena Umbilicalis*, which degenerates into a Ligament after the Birth.

The Liver is compos'd of Glandulous Kernels, Veins, Arteries, Nerves, Lymphatick and Cholerick Vessels : And the whole Composure is cover'd with a Membrane.

The exact Knowledge of the Fabrick of the Liver, is owing to Mr. *Malpighi* : He demonstrated, that 'tis compos'd of a great number of small Lobes, which appear when the Blood is taken out of the Vessels, and Water pour'd into 'em. Each of these Lobes, says he, receives a Branch from the *Porta*, one from the Bilious Vessel, and one from the *Cava* ; and are compos'd of Glandulous Kernels, which are all cover'd with a common Membrane, and sever'd from one another by particular Membranes.

The Vessels enter, or take leave of this Bowel either in its Concave, or its Convex part. The Vessels for the Bile, and the *Vena Portæ*, are inclos'd within one Sheath, or fleshy Membrane. They enter at the Concave part, and spread themselves all over the Substance of the Liver. The Branches of the Hepatick Artery, and some Twigs of Nerves accompanying these, are likewise inclos'd within the same *Capsula* ; nay, there are some Lymphatick Vessels that creep along that Sheath. The Liver receives three or four Branches of the *Cava* in its Convex part, which are equally dispers'd over all its substance : So that 'tis not to be imagin'd, that the *Porta* is confin'd to its Concave part, and the

Cava

Cava to its Convex-part ; since their Branches may be trac'd in all the Parts of this Intrail.

Tho' the Vessels cannot be trac'd so far as to the Glandulous Kernels, 'tis nevertheless probable, that in each of these Kernels there terminates a Branch of the *Porta*, one of the Gall-Vessels, and one of the Artery, all wrapp'd up in one Sheath, and a Branch of the *Cava* : So that 'tis in these Kernels, where the Blood of the *Porta* passes into the *Cava*, and the Bile separated from the Blood enters the Gall-Vessels.

From what has been said, 'tis manifest, that the Liver is a *conglomerate Glandule* ; but 'tis still doubted which are its Excretory Vessels : For the Lymphatick Vessels may serve it for Excretion as well as those for the Bile. If we consider that the Lymphaticks do not run into the Glandules, and are confin'd to their own Membrane ; we will readily conclude, that they are only Excretory Vessels for their own Membrane ; or at least, as *Malphigi* says, for some neighbouring Glandules. They terminate in the Cistern of the Chyle, which gave some occasion to think, that they're Milky Vessels. The Arteries of the *Liver* are deriv'd from the *Coeliaca*, and are wrapp'd up in the same Covering with the *Porta*. Its Nerves spring from the Eighth Pair, and make the *Hepatick Plexus*.

The Biliary Vessels must be examin'd very nicely, because there's a great deal of difficulty in adjusting their use.

I've told you, that the same Sheath encompasses both the *Biliary* Vessels, and the *Porta* ; and that the Branches of those Vessels accompany these of the Vein. To which I must add, that the Biliary Pipes, gathering into a Body, form a large passage, known by the Name of *Hepatick*, or *Forus Biliaris* ; and the Gall-Bladder produces

duces another which is call'd the *Cystick Passage*, or *Meatus Cysticus*; and both these joyning together, form the *Ductus Cholidochus*, which opens into the *Duodenum*.

The Gall-Bladder is seated in the lower part of the Liver. 'Tis shap'd like a little round Pear, and is usually divided into two parts, viz. the *Neck* and the *Bottom*. The Neck is a narrow part, and gives rise to the *Cystick Vessel*: The bottom is hollow, and pretty broad. 'Tis compos'd of three Tunics, the outermost of which is nervous, the middle one fleshy, and the innermost glandulous. The nervous Coat gives it force and power to resist; the fleshy puts it in motion; and the glandulous Coat being furnish'd with Nerves that terminate in it, entitles it to Sense. Its inner Cavity is plaister'd with a slimy Humour, that prevents the Corrosion which the Bile might occasion. The Bladder has several Biliary Roots which spring from the Liver, and open into its Cavity; for when the Liver is cut out, the Bile is seen to spring out of the Biliary Vessels that terminate in its Cavity. There's a Sphincter at the Orifice of the *Cystick Vessel*, which occasions the necessity of a strong pressure, in order to make the Bile come out of the Bladder.

There are several Opinions concerning the use of the *Gall-bladder*. The first is that of *Sylvius*, who alledges, that it converts the Blood convey'd to it by the *Cystick Arteries*, into Bile; and that one part of this Gall goes to the Liver, and another part to the Intestines: For when the Bile passes from the *Cystick Conduit* to that call'd *Cholidochus*; part of it, says he, moves into the *Hepatick Porus* towards the Liver, and the rest to the Intestine, through the *Ductus Cholidochus*. He backs his Opinion by an Argument taken from the great number of Arteries, Veins, and Nerves;

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that

that encompass the Bladder : And compares the Bladder to a Vinegar-Bottle, in which all other Wines turn sour.

But in regard that several Animals have their *Hepatick* and *Cystick* Ducts apart ; and some others, such as the Hart, the Chameleon, &c. have no Gall-bladder, tho' they have a *Porus Biliaris* ; 'tis probable, that the Bladder do's not make the Gall ; which is further confirm'd by making this Reflection, that the Liver is all over glandulous, whereas the Gall-Bladder has very few Glands to filtrate all the Gall that comes forth. Besides, we meet with Biliary Branches, which empty themselves into the Bladder. But that which gives the fatal Blow to *Silvius's* Opinion, is an Experiment that all the World are capable to make, *viz.* by taking a live Dog, binding him, cutting up his Abdomen, tying the Neck of the Gall-Bladder, cutting it up, and squeezing out the Gall ; and after that, tying the *Ductus Cholidochus*, near its Insertion in the Intestine (if you will, you may cut out the Gall-Bladder, and sew up the *Abdomen*). This done, the Creature will live some Days ; and if you open him again, you'll find a great quantity of Gall in the *Hepatick Porus*, and in the *Ductus Cholidochus* near the Intestine, which can only proceed from the Liver : So that 'tis an undoubted Truth, that the Gall is strain'd out in the Liver, and that the Gall-Bladder is only its Cistern.

Fallopious gives a different Account of the Use of the Bladder : He alledges, That when the Intestine is full of Chyle, and consequently has its Membranes stretch'd out, the *Ductus Cholidochus* is constrain'd to shut its Orifice ; and to prevent the recoiling of the Bile into the Liver, on that occasion, Nature has provided a *Cistern*, or *Receptacle* : For proof of his Allegation he says, the
Bile

Bile being an Excrement would infect the Chyle. But 'tis easily made to appear, that the distension of the Membranes of the Intestines, is so far from shutting the Orifice of the *Ductus Cholidochus*, that it rather contributes to keep it open, by withdrawing its Boundaries on all hands. In the second place, we know by Experience, that the Bile do's mix with the Chyle : So that this Advance must be rejected ; and we must fix upon this Conclusion, that the Bile both of the *Vesica*, and the *Porus Biliaris*, spring immediately out of the Liver. 'Tis true, the Bile of the one, differs something from that of the other ; but we are not therefore to conclude, that they are of a different Nature, tho' the subtiler goes to the *Bladder*, and the coarsest to the *Porus* : For that of the Bladder may owe its subtilty to its stay and fermentation in the Cistern, since it never comes out, but when the Bladder is squeez'd hard by the Ventricle, or when its Quantity is over-grown, or its Acrimony too great : So that the *Vesica* only gathers a quantity sufficient to render the Chyle more fluid and subtile ; and for that Reason its Gall is never voided, but when the Chyle comes into the Intestine.

To adjust the manner of the Filtration of the Bile in the Liver ; we must call to mind, that the *Porta* receives all the Blood that comes from the Arteries of almost all the Parts of the lower Belly. This Blood is very sharp, by reason of the close union of its Salts : For the Lymph that sever'd 'em, is separated from the Blood in the Glandules of the Ventricle, Intestines, and Sweetbread, and in other Glandules. If this sharp and gross Juice did continue to circulate along with the Blood, it might occasion vehement Fermentations : Upon which account it drops its sharp and saline Parts in the Glandules of the Liver.

But these sharp keen Particles would corrode the Fibres of the Glandule, and the Parts through which they pass ; if they were not temper'd by a soft and oily Liquor, which comes from the Caul to the *Porta*. But after all, notwithstanding the tempering of this sharp Juice with the oily Liquor, the Juice being very gross, might stick to the Fibres of the Liver, stop up their Pores, and gall them by its long stay ; if the Spleen did not furnish a sort of Blood compos'd of volatile and subtile Parts ; which, falling in with the Bile, augment its motion.

It may be objected, that the Caul being only a Cistern of Fat, which cannot be separated, but from the Blood in the Artery ; it must either remit into the Veins less Fat than it receiv'd from the Artery, and in that case, the Vein would have had a more oily sort of Blood, if the Artery had been joyn'd to the *Porta* ; or else it remits as much as it receiv'd from the Artery, and upon that foot the Caul will be good for nothing.

I answer, That the Liquor communicated to the Caul by the Artery, is not actually oily, and entangling ; but that it becomes such by virtue of its repose and stay in that part.

The Gall is compos'd of Volatile Parts, Lixivious Salts, and Oil ; which may easily be made to appear by its *Analysis*. 'Tis very probable, that the Bile would move but slowly, if the Pulsation of the *Hepatick Artery* did not accelerate the Motion of the Blood in the *Porta*, and that of the *Bile* in the *Biliary Pipes*, and so promote the ingress and egress of the Liquors. The Pulsation of the Diaphragm, and Muscles of the Abdomen, is likewise conducive in promoting this Motion ; for they press upon the Liver in every Respiration. The Bile, after its separation from the Blood, either moves to the *Gall Bladder*, or
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runs straight to the *Duodenum*. That which runs straight to the *Duodenum*, mixes continually with some remains of Chyle, which it renders more subtile, and at the same time dilutes the mucous Slime of the Intestines ; and by that means the Chyle is dispos'd to enter into the *Lacteals* upon the least compression.

There are some Set-times, in which the *Gall-Bladder* sends forth a greater quantity of Bile, and that somewhat sharper than what comes from the *Porus*. This *Bile* does not usually run into the Intestines, but when they receive the Chyle from the Ventricle : For, as I said before, the Stomach being then swell'd, presses upon the Bladder, and squeezes out the Bile ; from which it may be inferr'd, that a great quantity of Chyle is attended with a large quantity of Bile. Thus we see, how all the Motions of our Machine are regulated ; and, that what seems to be an Inconveniency, is often very useful, when we pursue the discovery of such things with some Reflection.

'Tis possible this new Opinion of the Generation of the Bile may be much oppos'd, because it allots new Uses to the Spleen and Caul. However, I think, I have grounded my Conjectures upon strong Reasons : For the extirpation of the Spleen and Caul, seems to vouch for the Uses that I have allotted 'em : Since, when the former is extirpated, the Liver is found to be dry'd up all over ; which shews, that this glutinous sharp Juice, not being qualified by the subtile Parts that the Spleen was wont to furnish, gradually corrodes the Fibres of the Liver : And upon the Amputation of a great part of the Caul, there ensues Loosenesses and Dysenteries, which in all probability proceeds from the deficiency of that oily Humour that us'd to concur in forming

the Bile, and wrap up the saline Parts, which, now they've more liberty, tear and rent the Guts.

It may be ask'd, if the Biliary Particles have any use in the Blood, before they're strain'd out?

I answer, That every part of the Bile, is for some use or other. The Oily part supplies the Bones, &c. the Volatile part puts the Blood in Motion; the Saline Particles split, break, and fix some parts of the Chyle in the Blood, and assist at all the Preparations in the Body.

Upon the same grounds, the Bile that mixes with the Chyle, serves for three principal Uses: With its Volatile Particles it puts the Chyle into Motion; with its Oily Particles it cements the Parts of the Chyle; and with its Saline parts it breaks off the Humour of the Intestines, and precipitates the coarse Parts of the Chyle.

Oftentimes some things are attributed to the Bile, that are only owing to one of its Parts; for instance: It is reckon'd the Cause of Anger, whereas 'tis only the extraordinary Motion of its Volatile part that deserves that Character.

T A B. VII.

Representing the Vessels of the Liver.

- a. *A part of the Liver fix'd to the back.*
- bbb. *The Vena Cava, and its Branches.*
- ccc. *The Vena Portæ, and its Branches.*
- d. *The Vesicula Fellea, or Gall-Bladder.*
- e. *The Cystick Branch.*
- f. *The Porus Bilarius.*
- g. *The Common Pipe, or Ductus Cholidochus.*

h h:





n h. *The Branches of the Nerves.*

o. *The Hepatick Artery.*

ii. *The Capsula laid open.*

K. *Some Lymphatick Vessels.*

l. *The Vena Umbilicalis, which serves for a Ligament in adult Persons.*

mm. *The Venous Passage of Communication between the Cava and the Porta in the Foetus.*

CHAP. X.

Of the Secretion of Urine in the Kidneys.

IN order to discover the hidden Course of Nature, we ought to follow her Foot by Foot, and perswade our selves that she always acts conformably to her own Operations, tho' their apparent diversity is such, that we cannot find out their similitude, without a great deal of application: For all that variety may fall within the same Laws: For instance, all the Filtrations that to us seem so different one from another, are calculated by the same Rules; the Kidneys strain out the Urine, in the same manner that the Liver do's the Bile. This will be made to appear by examining the Structure of their Parts.

In most Animals, the outer Surface of the Kidneys is unequal, and their whole Substance is compos'd of an infinity of little Lobes, which might pass for so many separate Kidneys. Tho' the Kidneys of Men are of a smooth even Surface, they are nevertheless compos'd of little Lobes, which appear plainly divided one from another; but they are so small, that the division is not sensible to the Touch. This alone is suffi-

cient to shew the conformity of the Kidneys to the other *Viscera*, that are employ'd in separating any Liquor from the Blood; since both the one and the other are compos'd of little Lobes, which are so many Glandules furnish'd with excretory Vessels.

The Kidneys are two Bodies that in Figure resemble a Bean; usually they're about four Inches and a half long, and one Inch thick: But both the length and breadth is much vary'd in different Subjects: For one Man's Kidneys may have twice that breadth and length; and another Man not half so much. They're seated in the Loins, between the Duplication of the *Peritonæum*; only the right Kidney lies a little lower than the left.

The Vessels that enter or go from the hollow part of the *Kidneys*, are a Vein, an Artery, Lymphatick Vessels, some Nerves, and a peculiar Vessel call'd the *Ureter*. This *Viscus* has two Membranes: The first is call'd *Adiposa*, or the Fat Membrane; and is furnish'd with a peculiar Vein and Artery, which are therefore call'd *Adiposæ*. The second Membrane covers the Kidneys immediately, and keeps all the Glands of which they're compos'd, in their due Situation.

The Veins of the Kidney open into the *Vena Cava*, and the Arteries spring from the *Aorta* near the first Vertebra of the Loins. These two Vessels make an Arch, and surround the whole back of the Kidneys. The Nerves are deriv'd from the *Plexus Renalis*, and from another *Plexus* near the Gall-Bladder. These Twigs of Nerves surround the Blood Vessels that enter into the Kidneys.

The Kidney is compos'd of two Substances; the outermost of which is red, and the inner one whitish. *Malpighi* has prov'd, that the outer,

or cortical Substance, consists of an infinity of small Glands; and conjectures, that some Branches of the Arteries, Veins, and Nerves, terminate in each of these Glands, and that each of 'em sends forth an Urinary Pipe; and that all the Urinary Pipes form the whitish or innermost Substance of the Kidneys. These small Urinary Pipes rallying together at the end, terminate in small *Papillæ*, that empty into the *Pelvis*, or *Basin*, and the *Ureters*, the Urine that is separated in the Glands.

Pursuant to this Conjecture, *Malpighi* ty'd a Ligature upon the Ureter, and the Emulgent Vein; and after the Animal had liv'd in that State for some time, he open'd it again, and says, he thought he saw some communication between the Glandules of the Kidney, and the Urinary Vessels, or the white Substance. *Gaspard Bartholin* tells us, that if we tie the Emulgent Vein, and syringe the Artery, a Liquor will come out at the Ureters. Tho' our Eyes cannot represent these Parts distinctly by reason of their smallness; yet we must suppose they are there, since all the Glands in the Body are supplied with Excretory Pipes, and those of the Kidneys cannot empty the Liquor they filtrate, but into the Urinary Vessels.

These little Pipes run from the Cortical Substance to the Centre, where they unite and gather into little Pyramids, which by reason of their Figure, are call'd *Papillæ*, or *Nipples*. In some Animals, Dogs for instance; these Nipples distill the Urine immediately into the *Pelvis*, or *Basin*: But in Men, each of 'em has a Pipe that conveys it to the *Pelvis*.

If we perceive aright that the Kidneys are thus form'd, and call to Mind what was before said of the Kidneys in general, 'twill be an easie matter

ter to explain the Filtration of the Urine. For since these Glands have Arteries, the Urine may easily be separated from the Blood, by Virtue either of the internal Figure and Disposition of their Pores, or their fineness. This Urine passes through the Urinary Vessels into the Basson, and from thence is convey'd by the Ureters to the Bladder. But according to this Explication, 'twill be very hard, if not impossible, to satisfy the following Queries : 1. How it comes to pass, that after drinking two or three Quarts of a pretty subtil thin Liquor, one passes it immediately ; for it must pass through the Stomach, the Intestines, the *Lactææ*, the Heart, the Lungs, and in a manner the whole Body, before its Filtration in the Kidneys ? 2. How it comes, that in a *Diabetes*, the Drink is voided in the same form that it was taken in, without any alteration in Colour or Consistence ? 3. How is it possible that Needles and Pins swallow'd, should be voided along with the Urine ?

These mighty Difficulties, mov'd some Anatomists to affirm, that there is a direct passage from the Ventricle to the Kidneys. But having look'd for 'em in vain, they quitted that Opinion and fancy'd that the *Lactææ* furnish Matter for Urine, by some Branches detach'd from the Cistern of the Chyle to the Kidneys. But upon a narrow sounding, they found that these Branches were Lymphatick Vessels, which are so far from conveying Matter from the Cistern to the Kidneys, that they carry Lymph from the Kidneys to the Cistern.

Mr. B—— has offer'd a new Conjecture, relating to this difficult Point, in the IV. *Journal de Medicine*, done by M. L'Abbe de la Roque : He alledges, that there are two Parts in the Urine; one sharp, and much loaded with Salts ; and the

the other sweet, and simply watery. He owns, that the first is separated from the Mass of Blood in the Kidneys : But makes the Watery Part to pass immediately into the Cavity of the *Abdomen*, through the Pores of the Membranes of the Stomach and Intestines, which are much dilated by their Natural Heat ; and to pass out of the *Abdomen* through the Pores of the Membranes of the Bladder into its Cavity. He grounds his Opinion upon these Arguments : 1. We may see by a turn'd Bladder, the Pores of the Bladder give passage to Water from without inwards. 2. The *Abdomen* of a Man that dy'd by Drinking, has been found full of Water ; which intimates, that Water may pass through the Intestines into the *Abdomen*. 3. This Conjecture explains, how Hydropick Bellies fall by voiding Urine. 4. Why the Excrements are liquid in the small Intestines, and solid in the great. And 5. Accounts for the sudden passing of Broth or other Liquors.

To all these Arguments, I reply, 1. That tho' the Pores of the Bladder allow a passage from without inward ; that will not avail, unless the Pores of the Membranes of the Intestines, allow a passage from within outward. And if Water runs out of a turn'd Bladder, 'tis through the holes of the Ureters that are cut. Besides, 'tis easily made to appear, that the Intestine admit of no passage from within outward, unless it be into the *Venæ Lactææ* : For 1. We cannot make the thinnest and subtilest Liquors pass that way. And, 2. If there were any such passage, the *Abdomen* would be full of Water in a Suppression of Urine. 2. In a preternatural State, the Intestines may be crack'd, or unperceivably perforated ; as in the Case of the Man that dy'd by Over-drinking, his *Abdomen* might well be fill'd with Water,

ter, because the Quantity of the Liquor had broke his Intestines. 3. In Hydropical Persons the Swelling is abated by pissing more than usually, both because the Serosity of the Blood being voided by the Kidneys, it does not fall so much on the *Abdomen*; and because the Hydropical Water returning into the Veins is voided by Urine, just as Pus in the Breast is oftentimes voided by Urine, by repassing through the Blood. Besides Mr B— must suppose an Obstruction in the Pores of the Bladder, to explain the Nature of the Dropsie after his way: And if it were so, the Swelling would fall every time they make Water; or at least their Urine would be very deep loaded, which is often false; and the passing of their Urine, tho' never so little, would quickly cure 'em, since the Obstruction of the Pores of the Bladder would then be remov'd: Which is all contrary to Matter of Fact. 4. The Excrements are liquid in the small Intestines, by reason that there the subtile Parts are incorporated with the gross; but after the separation of the subtile Parts by the *Vene Lactea*, the gross remainder must needs be solid. 5. Had we a just Idea of the Rapidity of the Circulation and Distribution of the Liquors, we would not be amus'd with the quick passing of Broth. But besides the Answers I've now given, some *Objections* may be started against his Opinion, which to my Mind are unanswerable. 1. We find no such difference between Urine taken out of the Ureters, and that of the Bladder, as he supposes. 2. If you put a Ligature on the two Ureters of a live Animal, and sew up his Belly, suffering him to live, you will not find a drop of fresh Urine in the Bladder. In fine, do not we meet every Day with Suppressions of Urine, occasion'd by an Obstruction in the Ureters?

As for the Needles and Pins voided along with the Urine ; if it is Matter of Fact, these Needles must have perforated the Stomack, or Guts, and penetrated into the Bladder.

Above each Kidney there lies a blackish Glandule, ty'd to the *Membrana*, near to a *Plexus* of Nerves. They're call'd *Capsula Atrabiliaria*. They're so large in the *Fœtus*, that their Bulk equals that of the Kidneys. But in adult Persons they are much smaller ; whether it be that they give over growing, or that they shrink and dwindle. However, the right one is a little larger than the left one. 'Tis observ'd, that in a Phtisick, when all the other Parts dwindle, they receive no diminution. They present us with a small Membrane, and a very plain perceivable Cavity fill'd with an Oily Liquor. They are supplied with some Arteries, either from the Trunk of the *Aorta*, or from the *Emulgent Arteries*; and Veins that terminate in the *Cava*, or in the *Emulgent Veins* ; and some Nerves deriv'd from the Stomachick Nerve. Their Veins rise out of their Cavity, and at the entrance of each Vein is plac'd a Valve, that allows a passage for the Humours from the Cavity to the Vein, but no return from the Vein to the Cavity.

As I take it, these *Capsula Atrabiliaria*, serve for almost the same use with the *Membrana Adiposa*. Both the one and the other strain out a Liquor, which by its long stay becomes Oily: And after that, throw it into the Veins ; where the Blood, that was stripp'd of its Fluidity by the Secretion of its Serous Parts, recovers its former State, and its Parts that hang'd but loosely together, are compacted by this Liquor : So that these Glands do the same Office to the Blood of the *Cava*, that the *Omentum* do's to that of the *Porta*. Upon this Foundation, 'tis easie to give
a Rea-

a Reason, why the sharp and corrosive Juices, that in a Phtifick over-run and destroy all the Parts of the Body, have no influence upon these Glands; and why they grow larger in young Children, but not in Adult Persons. For since Children are fat and moist, these *Capsulae*, as well as the other Parts, retaining to the Fat, must needs enlarge their Bulk.

The Ureters and the Bladder, are the only remaining Parts employ'd in the Excretion of Urine, that we have not yet examin'd.

The Ureters are long, round, and very narrow Pipes, of a Membranous Substance, fill'd with Nerves, some Arteries, and some Veins. I told you above how they are form'd in the Kidney; and now 'twill be sufficient to add, that they open into the sides of the Bladder, towards the middle, but very obliquely; and there form among their own Membranes a passage of seven or eight Lines in length: So that the Urine, or Wind contain'd in the Bladder, cannot get out by their Mouth; for the same Matter that offer'd to get out, would of it self stop the passage, by thrusting the Walls of the Ureters together.

Usually there is but one Ureter for each Kidney; sometimes I have found two.

The Bladder is a Membranous Bottle, seated in the *Hypogastrium*, upon the Womb in Women, and the *Intestinum Rectum* in Men. The upper part of the Bladder is ty'd to the Navel by a Ligament call'd *Urachus*. 'Tis compos'd of Veins, Arteries, and Nerves, which are all Branches of the *Hypogastrick* Vessels. It has three Tunicles. The outer Coat is nervous, and of a tender Sense. The second is fleshy, and serves to contract the Bladder, and expel the Urine. The third is glandulous, and filtrates a Mucilaginous Matter, which screens it from the Injury of the Salts of the Urine.

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Tab. 8. Pag. III.

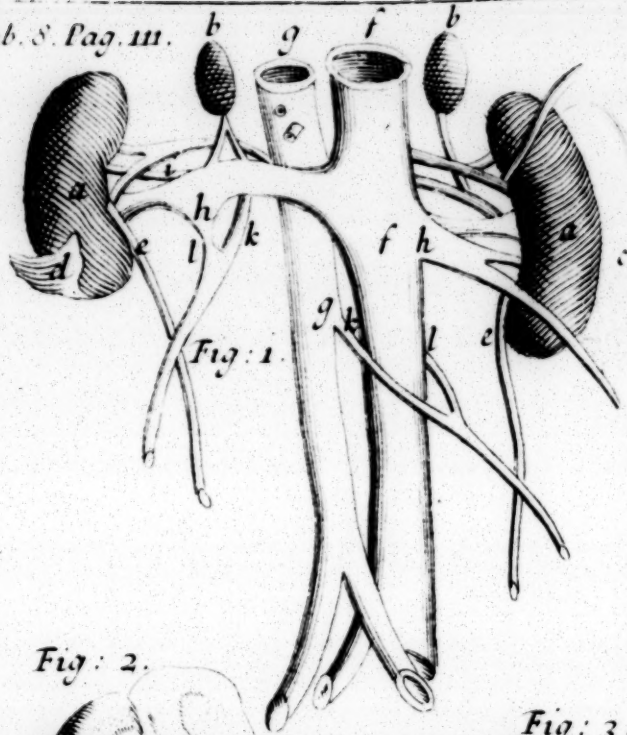
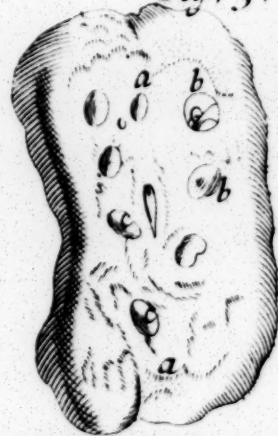


Fig: 2.



Fig: 3.



T A U V R Y'S ANATOMY. III

The *Bladder* runs out length-ways into a Neck, the production of which is call'd the *Urethra*. In this Neck there stands a Bunch of fleshy Fibres, call'd a *Sphincter*; which in its natural Situation shuts the Neck, and prevents a perpetual Flux of Urine: Except when the abundance of Urine, joyn'd to the pressure of the Muscles of the *Abdomen*, and the fleshy Fibres of the Bladder, push with a force superiour to that of this Muscle, and so oblige it to give way. Having laid down these Principles, we may easily perceive, why those who retain their Urine for some time, cannot afterwards void it without difficulty; since the over-bearing quantity of Urine, and its Acrimony, may have shut down the *Sphincter* by the Sense of Pain or Fretting.

T A B. VIII.

Representing the Kidneys, the Capsulæ Atrabilaria, and the adjacent Branches of the Aorta and Vena Cava.

Fig. 1.

- a a. *The Kidneys.*
- b b. *The Capsulæ Atrabilaria.*
- c. *The Membrana Adiposa.*
- d. *The proper Membrane of the Kidneys.*
- ee. *The Ureters.*
- f. *The Vena Cava ascending.*
- g. *The Aorta descending.*
- h h. *The Emulgent Veins.*
- K K. *The Spermatick Arteries.*
- ll. *The Veins.*

Fig.

Fig. 2.

- a a. *The Kidney dissected.*
- b. *The Bason.*
- c. *The Ureter.*
- ddd. *The Branches of the Ureter embracing the Caruncles.*
- ee. *The Carunculæ Papillares, or Nipples.*

Fig. 3.

- a a. *The Kidney cut up.*
- bb. *The Orifices of the Ureters embracing the Carunculæ Papillares.*
- cc. *The Caruncular Nipples.*

C H A P. XI.

Of the S E E D.

THE Seed, or Sperm, is first separated from the Blood in the Testicles, which are two glandulous, round, long Bodies, resembling both in Bulk and Figure a small Hen-Egg. They're seated in the *Scrotum*: They're furnish'd with Arteries, Veins, Nerves, Lymphatick Vessels, and, which is peculiar to them, Vessels that carry off the Seed, call'd *Vasa Deferentia*.

The Artery, Vein, Nerve, and Lymphatick Vessels, retaining to the Testicles, are all call'd *Spermatick*. The Arteries spring from the Trunk of the *Aorta*; the Vein on the right side runs into the Trunk of the *Cava*, and the other to the

the *Emulgent*. The Arteries and Veins joyn and cleave together towards the end of their Progress; upon which the Ancients alledg'd, that the Vital Spirit of the Arteries mixes with the Venous Blood, in order to commence the working and refining of the Seminal Matter. But upon a narrower view, they acknowledg'd, that these Vessels do only touch one another, and even when the Artery and Vein twitt round one another by several Circumvolutions, and form the *Pampini-forme*, as it happens in several Animals; even in that Case they remark'd, that if you Syringe the Artery, the Liquor will not return by the Vein, without passing through the Testicles; and that this Part observes the Rules of Circulation, as well as other Parts. The Nerves accompany these Vessels, and are deriv'd from the *Plexus Mesentericus*. The Lymphatick Vessels steer their Course to the *Receptaculum*. All these Vessels, together with the *Vas Deferens*, are wrapp'd in the *Tunica Vaginalis*.

The Testicles are usually in number two, sometimes three, and sometimes one. *Fernelius* tells us, that he knew a Family, of which all the Males had three Stones: But that is very unfrequent.

The Testicles have five Coats, two common and three proper ones. The First, is the *Scrotum*, or *Cod*, which is only a continuation of the external Skin in this part. In the middle it has a Seam, which is only a Fold of the Skin. The Second Coat is call'd *Dartos*. 'Tis a cuticular Muscle, which wrinkles and furls the Cod, when it swells or contracts it self, (as it often happens in cold Weather.) These are the Membranes that cover both the Testicles: But there are other Coats that cover each of 'em apart.

114 TAUVRY'S ANATOMY.

The first is fleshy. It covers the Testicle, and then parts from it, and cleaves to the *Spina* of the *Os Pubis*; so that when it swells and shortens it self, it draws up the Testicle. This Membrane is call'd *Musculus Cremaster*, or *Suspensorius*.

The second is the *Tunica Vaginalis*, which contains the Vessels that come in, or go out of the Testicle. 'Tis justly taken to be a continuation of the *Peritoneum*: For tho' some Modern Authors have given it in for a prolongation of the Rings of the Muscles of the *Abdomen*; they afterwards own'd themselves mistaken.

The third is the *Tunica Albuginea*, the immediate Cover of the Substance of the Testicle.

The Substance of this Part, is only a Clew of Seminal Vessels: The Discovery of which is owing to *M. Graef*. He tells us, That some time after he had ty'd the *Vasa Deferentia* of a living Animal, the small Vessels of the Testicle became full of Seed, and visible. Besides, one may undo the Testicle almost like a Clew of Thread, especially that of a Rat.

The Branches of the Spermatick Artery in the Testicle, produce those Seminal Vessels, which afterwards form the *Epididymes*, *i. e.* two white and long Bodies, each of which is fasten'd to one of the Testicles, towards the Ends of the upper part; and not at all to the middle part of it; and withal, cover'd with the *Tunica Vaginalis*. When we unravel it, we find it to be only a Pipe or Vessel winded up, the length of which in Man is five Ells. It gives rise to the *Vas Deferens*.

Authors are much puzzl'd, to know how the Seed filtrates in the Testicles, passes into the *Epididymes*. *Higmore* says, he found in the middle of the Testicle, a white, hard, and solid Body, like to the *Vas Deferens*; which runs from the
bottom

bottom of the Testicle towards its upper part, and perforating the *Tunica Albuginea*, is inserted into the Head of the *Epididymis*. *Diemerbroeck* says, he saw it likewise; and that to his Apprehension, all the Fibres of the Testicle terminated in it. He does not follow *Higlmorus's* Opinion, in making it serve for a passage for the Seed, from the Testicle to the *Epididymis*; but thinks 'tis only employ'd to bear up the Vessels of that part. *Graef* pretends, that it is not one, but six or seven very small Ducts, that are the Instruments of this communication. Some Anatomists tell us, they have look'd for *M. Graef's* Ducts, but could never find 'em; but that they have clearly perceiv'd that of *Higlmorus's*. Indeed, I have seen a sort of Duct like to that describ'd by *Higlmorus*; but I could not perceive whether it was hollow or not. However, this is the only way yet found out, for passing the Seminal Liquor out of the Testicle into the *Epididymis*. And 'tis probable, the *Epididymis* is nothing but a continuation of that passage; and that the little Seminal Vessels open into it by different Branches, as into a sort of Cistern.

When the *Vas Deferens* rises out of the *Epididymis*, it ascends along with the Epimurick Vein, and terminates in the Neck of the Bladder; where it communicates by some Offices with the *Vesiculae Seminales*. 'Tis a hollow Vessel, tho' it seems to be solid and hard; for if you blow into it, you'll see it swell. For an evident Proof of its communication with the Seminal Vesicles, blow into it, or inject some Liquor by a Syringe, and you'll see the Vessels swell before the Liquor runs out at the *Urethra*.

The *Vesiculae Seminales*, are little glandulous Cavities, supply'd with Veins, Arteries, Nerves, and fleshy Fibres; and communicating, as I said

but now, with the *Vas Deferens*. Some say they receive the Seed from the *Vas Deferens*, and reserve it, but *Wharton's* Opinion is more probable, viz. that they filtrate another sort of Seed, and throw it into the *Vas Deferens*.

After that, the *Vasa Deferentia* continuing their progress to the *Urethra*, pass by two large Glandules call'd *Prostate*, from which they receive a Serous Humour, by some holes towards the ends.

In the beginning of the *Urethra*, we meet with a little glandulous Kernel, call'd *Verumontanum*, which hinders the egress of the Seed, except when the large quantity, or Acrimony of the Seed overpowers it.

Upon these Principles 'twill be easie to build an Account of the Filtration of the Seed. As I take it, the *Spermatick* Artery conveys the Blood to the Testicle, and the Veins carry it off again, as in other Parts. But such Parts of the Blood as are of a certain size and fineness, are separated from the Mass, and thrown into the little Seminal Pipes; which reuniting into one passage, as *Higbmorus* says, convey them to the *Epididymes*, from whence they run into the *Vas Deferens*. By circulating through so many Windings, and Contorsions of Seminal Vessels, these Parts grind and subtilize themselves, partly by reason of the smalness and length of the Vessels, and partly upon the account of their Contortion.

When this Liquor is arriv'd at the *Vas Deferens*, it mixes with another Liquor thrown out by the *Vesiculæ Seminales*, by contracting themselves. At last, the Glandules call'd *Prostate*, pour forth a third Liquor that mingles with the Seed. And of these three Liquors is the Seminal Matter form'd. The Testicles furnish the most Spirituous Part, the *Vesiculæ* the most Watery Part, and the *Prostates* the most Oily.

It

It remains now to describe the *Yard*; the external Parts of which I shall pass by, as being of no great importance.

The internal Parts of which the *Yard* is compos'd, are Veins and Arteries, call'd *Padenæ*, deriv'd from the Hypogastrick Vessels, and Nerves rising from the *Os Sacrum*.

It contains likewise two great Nervous Bodies, which are spongy, *i. e.* fill'd with Cells, that are furnish'd with a great number of Veins and Arteries. These Nervous Bodies take rise from the *Os Ischium*, and accompanying the *Urethra*, terminate at the *Glans*. The *Urethra* is a Pipe produc'd by lengthning the Neck of the Bladder, which voids both the Seed and the Urine.

There are four Muscles at the Root of the *Yard*; two of which are call'd *Erectores*; and two *Acceleratores*. The first are thick and short; and fasten'd by a Tendon to the Tubercles of the *Os Ischium*. The *Acceleratores* are slenderer and long. They're fasten'd to the *Sphincter* of the *Intestinum Rectum*, and reach to the middling and lateral part of the *Urethra*. All these Muscles serve for erecting the *Yard*, by swelling and shortning themselves, and compressing the Veins and spongy Bodies: For by that means they prevent the return of the Arterious Blood by the Veins, whereupon Erection ensues. Syringing the Artery in a dead Body, will erect the *Yard*; which shews, that the sole abundance of Blood is sufficient to compass that effect, without the assistance of the Animal Spirits.

By this Description we may resolve several Questions: 1. Why the Seed contain'd in the Seminal Vessels, do's not usually come forth without the Influence of Fancy and the Erection of the Part? 2. Why the Urine is not voided along

with the Seed? 3. Why a Debauchée voids Drops of Seed when he goes to Stool, or makes Water? 4. Why Eunuchs and Women are Beardless?

In order to resolve these *Phænomena*, we must suppose, that the most Volatile and Oily Parts of the Blood, being agitated by the Particles that fly off from the belov'd Object, whether really present, or represented by Fancy; insinuate into the Pores of the Seminal Vessels, and by rarifying the Seed, oblige it to require a larger space: Upon which it endeavours to get out, and in its egress rubs and jostles the Membranous Parts more than usually; which is partly the cause of the tickling Pleasure that attends the emission of that Liquor.

1. The Store-houses of the Seed, do not expel it, without they are straiten'd by the distention of the adjacent Parts; which happens when the Spirits repair in such plenty to the Parts, that the *Cremaster* Muscles shorten themselves; and by pulling up the Testicles, squeeze 'em, and so force the Seed to ascend.

2. The Neck of the Bladder, and the *Prostates*, are encompass'd by a great many fleshy Fibres; which keep in the Urine, when the Seed is thrown out: For in the emission of Seed, the *Prostates* are constring'd by the distention of the fleshy Fibres, which at the same time straitens the Neck of the Bladder, and prevents the Flux of the Urine.

3. The Seminal Vessels are much enlarg'd by frequent Amours: So that upon the least Constriction of the Cisterns of the Seed, there ensues an involuntary emission. Now, when one goes to Stool, or makes Water, the *Sphincters* shorten themselves, and squeeze the Parts to which they are knit.

We

We are not therefore to think it strange, that on such Occasions some Drops of Seed are voided by such Persons, since the shortend Muscles constringe the Seminal Vessels, and the *Prostates*, which they cover.

4. 'Tis an unquestion'd Truth, that Men owe not only their Being, but part of their Strength to the Seed : Since Eunuchs and Women, and those who enervate themselves by repeated Venerie, are much weaker. The Seed being shut up in the Seminal Vessels ferments there, and increases the Motion and Subtility of its Parts. Accordingly, when it returns to the Blood, it makes such alterations, as it could not have produc'd without being exalted in the Seminal Vessels. When these Vessels are once full, and more Seed presents, the first is oblig'd to move off into the Veins : Upon which it circulates with the Blood, and prevents the dissipation of the Spirits. And perhaps 'tis upon that account, that the loss of a large quantity of this Oyl in the Act of Venerie, is follow'd by a weakness.

The Seed fortifies the Membranous Parts, especially the Lungs ; which it defends from the sharp Salts that might injure its fine and slender Membranes. It keeps in the Particles that should nourish the Hair, and make it grow. Over and above all these Effects, it gives a Warmth to the Fancy, it puts the Blood in a fermentation, and enables a Man to Love : For which Reason, 'tis, that whatever impairs the quantity of the Seed, or diverts the Imagination, is an Antidote against Love.

So much for the Effects of the Seed. I shall only add, that its Oily Part, even before 'tis perfected in the Seminal Vessels, hinders the sharp Salts to exert their force in the Body : And therefore, says *Hippocrates*, Eunuchs, and Children

unacquainted with Venery, are exempted from the Gout.

T A B. IX.

*Representing the Spermatick and Seminal Vessels,
as they are in a Man.*

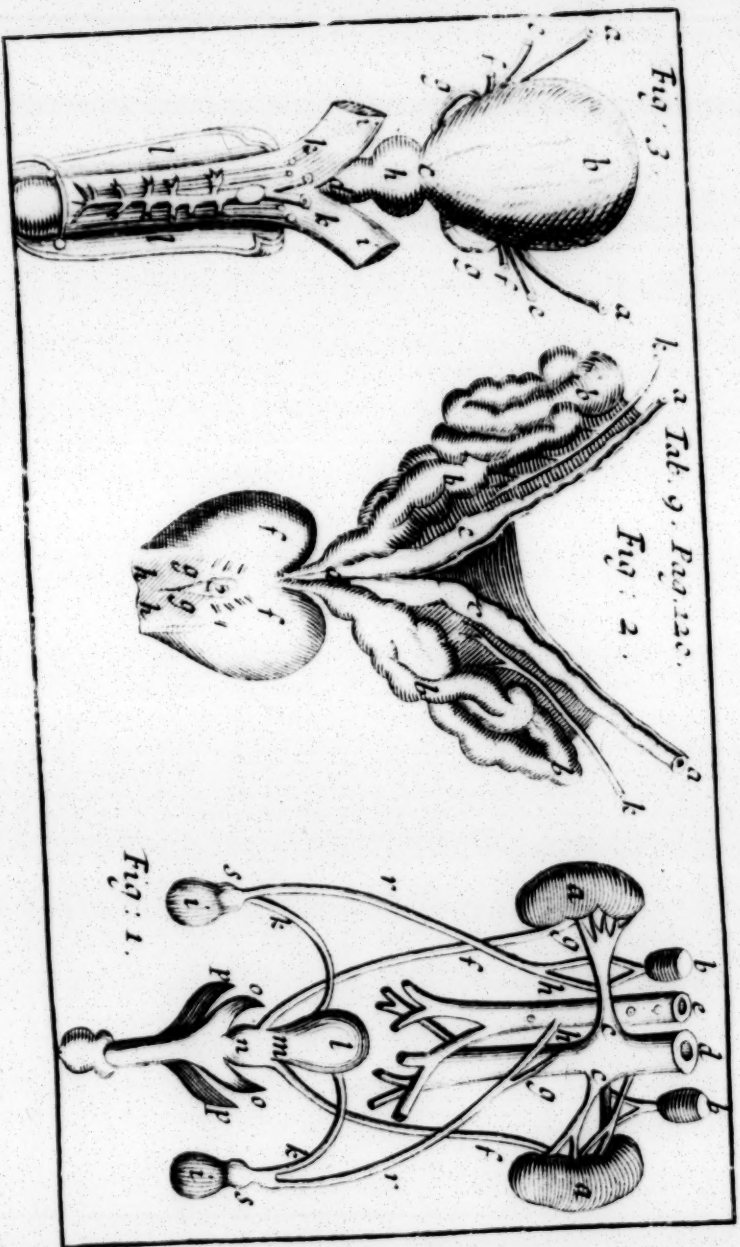
Fig. 1.

- aa. *The Kidneys.*
- bb. *The Capsulæ Atrabiliaræ.*
- cc. *The Emulgent Veins.*
- d. *The Trunk of the Cava.*
- e. *The Trunk of the Aorta.*
- ff. *The Ureters.*
- gg. *The Spermatick Veins.*
- hh. *The Spermatick Arteries.*
- rr. *All the Spermatick Vessels together.*
- ff. *The same Vessels forming the Corpus Pampyniforme.*
- ii. *The Testicles wrapp'd in their proper Membrane.*
- kk. *The Vasa Deferentia, which terminate behind the Bladder.*
- l. *The Bladder.*
- m. *The Neck of the Bladder.*
- n. *The Prostates.*
- o. *The Musculi Erectores.*
- p. *The Musculi Acceleratores.*

Fig. 2. From De Graëf.

- aa. *The Vasa Deferentia.*
- bb. *The Seminal Vesicles.*
- cc. *That part of the Vasa Deferentia that is dilated.*

d. *The*





- d. *The place for communication with the Vesiculæ.*
- ee. *The Caruncle with two holes for the egress of the Seed.*
- ff. *The Glandulous Bodies call'd Prostates.*
- gg. *The Pipes of the Glandulous Bodies, on the sides of the Caruncles.*
- h. *The Urethra laid open.*
- i. *The Membrane that encloses all its Parts.*
- K K. *Some Vessels running to the Vesicles.*

Fig. 3.

- a a. *The Ureters.*
- b. *The Bladder.*
- c. *Its Neck.*
- d. *The Urethra.*
- ee. *Part of the Vasa Deferentia.*
- ff. *The Vessels that open into the Vesiculæ.*
- gg. *The Vesiculæ Seminales.*
- h. *The Glandulous Bodies.*
- ii. *The Musculi Erectores.*
- K K. *The Corpora Nervosa separated from the Os Pubis.*
- l. *The Skin of the Yard.*
- m. *The Back of the Yard, with its Vessels.*

C H A P. XII.

Of the Seed of Women.

IN the Parts of Women ministring to Generation, 'tis to be observ'd, that the Spermatick Arteries come from the *Aorta*; the Nerves arise from the *Par Vagus*; the Lymphatick Vessels run to the *Receptaculum*; and the Veins open into the
Cava,

Cava, and Emulgent, just as in Men. But these Vessels are divided much otherwise than in Men, where they joyn the Parts ministring to Generation. In Women, the Artery and Nerve do each of 'em detach four Branches, the first of which goes to the *Testicles*, the second to the *Tube*, the third to the Neck of the Womb, and the fourth to the bottom, or *Fundus Uteri*. Both the Vein, and the Lymphatick Vessel, receive likewise four Branches from these four Parts.

The *Testes* are seated on the sides of the bottom of the Womb, at the distance of two Fingers breadth. They are a little flat, and less than those in Men by one half. They receive a Branch from each Spermatick Vessel. Their Substance is compos'd all over of little Bladders, fill'd with a Liquor peculiar to themselves; so that they differ much from those of Men, since they are neither a conglobate Glandule, nor a Collection of Vessels as in Man. 'Tis true indeed, they may be taken for conglomerate Glandules, of which more anon.

They have only a proper Membrane, which compacts all the Vesicular Glandules, of which 'tis compos'd: Each Vesicle may be look'd upon as a glandulous Cavity, receiving the Capillary Ends of the Vessels that enter into the Testicle: Nay, we may reasonably believe, that they are surrounded with fleshy Fibres, as well as all the other Cavities of the Body. This will afford an easie Explication of the Caruncles, which appear in the Testicles of Animals after Conception; for when several Vesicles empty themselves, and their fleshy Fibres sink lower, they may well represent a small Eminence of Flesh, standing by a void space, just forsaken by the Egg. Without this Supposition, I cannot see how the Origin of the Caruncles can be accounted for.

I shall

I shall not dip very deep into the Question of the Eggs, because I take that Hypothesis to be useless; besides, there are as many Reasons and Experiments against it, as there are for it. In earnest, do's the falling of the Seed from a Testicle, wrapt up in a Membrane, illustrate the Matter more than the Opinion of those, who believe it falls from thence in the form of a Liquor? Had the Votaries to this new Hypothesis explain'd the Formation of a Chick in the Egg; one would have been apt to believe them, that Man springs in like manner from an Egg: But we don't find, that all their Supposals account for the Order and Ranging of the Parts, and for all the Mechanism that the Business of Formation requires. They suppose the Man quite form'd in the Egg; but the Question is, How this Form is brought about.

'Tis true, those who vouch for the Opinion of the Eggs, alledge, That it is not necessary to account for the manner and way of forming the Man; and that it is sufficient to suppose him already form'd. But that Opinion is attended with an inconvenience, which I believe they are not aware of. They must needs affirm, that all the Men that now are, that have been, and that shall be, were all form'd and contain'd in the *Testes* of the first Woman. They make no difficulty in giving in this Assertion; but in the mean time, 'tis a very strange one: For, if they reflect on the Proportion of the Bulk of the Woman's Body to her *Ovaria*, and on that of her *Ovaria* to each of her Eggs, which in their Opinion is a compleat Woman, and shall have *Ovaria*, and Eggs of its own, and these Eggs again being other compleat Women will have *Ovaria* and Eggs, which still are suppos'd to be compleat Women; upon this Reflection, I say, before we carry the Calculation

tion down to the Third Generation, we will find that these little Women will be less than the homogeneous Particles of the subtilest Liquors, and therefore cannot be organiz'd and living Bodies; unless we take up with the ridiculous Advances of some Philosophers, who make all Bodies to have Life.

M. Lewenhoeck, and some other Moderns alledge, That the Animal is not form'd in the Egg, but in the Seed of the Male, pursuant to the Observations, they say, they have made with Microscopes upon the Seed of several Animals: In the Seed of a Bull, for instance, they descry several Bulls, &c. This Opinion is expos'd to the same Difficulties with the other; and these are unanswerable, unless we suppose that there are in the Air, all sorts of Animals quite form'd, which we swallow; and that the little Men thus suck'd in by Respiration, are filtrated with the Seminal Liquors, and continue in the Man; that the little Dogs flying in the Air, lodge themselves in Dogs; and that the little airy invisible Elephants, do only fix in the Spermatick Parts of earthly visible Elephants. If we consider the Groundlessness of these Suppositions, we'll find they were only invented to guard off the difficulty of explaining how Man is form'd.

This last Opinion has one Inconvenience fewer than the former, in regard the size of its little Men is conceivable; whereas in the other 'tis not to be conceiv'd, by reason of the different Degrees of Magnitude in the different Generations. But it do's not avoid the Difficulty of the *Form*, since they are still to explain, how these little Æthereal Men were form'd.

The *Testes* of Women have one, or several Excretory Pipes, which convey the Seed, or Egg, into the Womb; but it is doubted which are they.

they. Some think, the Egg falls into the Womb thro' the *Fallopian Tube*: But since the *Testes* of Women are cover'd with a strong Membrane, it is not probable that the Egg perforates that Membrane. Others fancy, that the Ligament which fastens the Testicle, and runs to the *Tube* and the Womb, is the Excretory Vessel.

Having thus dispatch'd the Structure of the *Testes*, we come now to describe that of the Womb. It has the Figure of a Bottle, seated between the Bladder, and the *Intestinum Rectum*; and is greater or smaller, according to the difference of Age and Constitution. 'Tis largest in those who are given to frequent Venery, and above all in Women with Child; but in Virgins it is very small. Its Membranes are pretty thick, and become more such by *Gestation*, because it is of a Spongy and Cellenary Nature: For we must consider it as being compos'd of little Bladders, which being fill'd with Blood, enlarge their length and breadth.

In the Womb we distinguish the *Fundus*, or Bottom, and the Neck. On the bottom of the Womb, we observe the Ligaments, the *Tube*, or Trumpets, and the Horns.

The bottom is fix'd by four Ligaments; two of which are Membranous, furnish'd with fleshy Fibres, which fasten it to the *Ossa Ilii*. These Ligaments take their rise near the Horns, and are shap'd like the Wings of a Batt. The two other Ligaments are round and pretty small; they take their rise at the sides of the bottom of the Womb, and from thence ascend, and are fasten'd to the *Os Pubis*, near the Roots of the *Clitoris*. Some alledge, that part of the Seed is convey'd by the *Vasa Deferentia* to this Ligament, to be transported by it to the *Clitoris*; to which purpose *Dinerbroeck* tells a Story of a Woman that voided Seed at that part. The

The *Tubæ* are two large Pipes, pretty broad, rising out of the bottom of the Womb, and growing larger as they ascend. Their end is open towards the Testicles, and jagged like a Fringe. Some Anatomists pretend, that they supply the place of the *Epididymis*: And as the Seed of Man after its preparation in the Testicles, passes into the *Epididymis*; so that of Women being prepar'd in their *Testes*, repairs to the *Tubæ*. *M. Postel* has publish'd an Experiment to back this Opinion, *viz.* That in a leud Woman he saw the *Testes* and *Tubæ* full of Seed; but that Experiment will equally prove, that the *Tubæ* engender Seed, or that they receive the Male-Seed: This last Opinion is so much the more probable, that form'd *Fetus's* have been often found in the *Tubæ*.

At the sides of the bottom of the Womb, we likewise descry two Risings, which are call'd *Cornua*.

The Substance of the Womb consists of two Membranes, inclosing a Spongy or Vesicular Body, which makes the Womb to grow larger and thicker; tho' indeed all Bodies seem to impair their breadth, as they grow in length.

The Womb is supply'd with several Arteries and Veins from the Spermatick and Hypogastrick Vessels: The Arteries joyn with the Arteries, and the Veins with the Veins; by which means, where the Spermatick Vessels are stopt, the Hypogastrick will still furnish all the Parts of the Womb with Blood.

The Orifice at the bottom of the Womb, joyn-
ing to the Extremity of the Neck, is call'd the
internal Orifice, and guarded with a Sphincter,
which empowers it to open and shut it self. It
opens in the time of Delivery, and during the
Flux of the *Terms*: But after Conception, *Hip-
pocrates*

pocrates says, 'tis shut so close, that the Point of a Needle cannot enter. But the Superfoetations and Miscarriages of Big-belly'd Women, evince that it is not always so.

Next to the internal Orifice is the Neck of the Womb, or the *Vagina*, which is a long Passage well stor'd with fleshy Fibres and Vessels, which enable it to constrict and heat the Yard in Coition. At the external Orifice of the *Vagina*, we meet with the *Mons Veneris*, the *Labia*, the *Nymphae*, the *Clitoris*, the Navicular Cavity, and the Orifice of the *Urethra*.

Tho' Decency obliges us to be modest in describing these Parts, yet I thought it not improper to give some Account of their Structure, since it is very necessary to be known.

The highest Part, which is cover'd with a fine sort of a Down on those who begin to be of Age, is called *Mons Veneris*. It is a little Cushion seated upon the *Os Pubis*, that serves to keep off the hardness of that Bone in the Act of Venery. At the lower part of this Mount, we meet with two Bodies, with a Slit between 'em; which in Colour don't differ from the Skin, but are cover'd with a curl'd Hair: We call 'em *Labia*. When we put aside the *Labia*, we descry in the lower part, a Membrane, which forms a pretty deep Cavity, call'd *Navicularis*. Under the Lips stand two Membranes, one on each side; which are pretty long, and of a red Colour: We call 'em the *Nymphae*. Towards their upper Parts, under the *Mons Veneris*, between the two *Labia*, there appears a small Rising, which is call'd the *Clitoris*; and sometimes shoots it self out to that degree, that Women may employ it to a wrong use; upon which account 'tis call'd, *Penis Fæmineus*. Above the *Clitoris* there is a little Hole cover'd with a little Membrane, which is the Orifice of the *Urethra*. Under

Under this Hole we meet with another, which receives the Yard ; the Entry of which is said to be the Seat of the *Maidenhead*. It presents us with four little Knobs, which stop almost the whole passage, and are call'd *Caruncule Myrtiformes*. Some Anatomists add, that in Virgins there's a Membrane in this place, which they call the *Hymen*. But, as *Riolanus* says, 'tis not to be found in all Maids ; for they may break it with their Fingers, or it may be torn by sharp Humours passing along. At the entry of the *Vagina*, between the fleshy Fibres, and the Membrane within, we descry a Glandulous Body about a Finger's-breadth thick, which extends itself to the Neck of the Bladder, and has some Excretory Vessels call'd *Lacune*, which terminate in the lower part of the Womb, and furnish the Humour that Women spurt out in their amorous Embraces. M. *Du Vernay* says, he has found out two other large Glands, seated upon the side of the *Vagina*, which furnish a great part of that Moisture. But he might have added, that he found them only in Brutes, and not given it in for a Discovery made upon Women, in whom they are not to be found.

The *Clitoris* lies under the Glandulous Bodies of the *Vaginae*. 'Tis compos'd much after the same manner with a Man's Yard, bating that it has no *Urethra*, that it is much smaller, and that it is not perforated : For there are two Nervous Bodies, which rise from the *Os Ischium*, and make the Legs or Roots of the *Clitoris* ; and after that uniting forms its Body. It has four Muscles of the same Structure and Use with those of Men ; I mean, that they serve to inflame the *Clitoris*, by detaining the Blood in the Veins, and the Nervous Bodies. This Inflammation exalts the Pleasure, and by constringing the Glandulous

dulous Bodies, makes them squirt out the Liquor they contain.

Pursuant to our wonted Order, I come now to explain their Uses. 'Tis certain, that the Blood circulates in the *Testes*, as well as in the other Parts of the Body; and that the Parts which are qualify'd to enter the Pores of the *Vesiculae*, enter into 'em; and are afterwards convey'd to the *Vas Deferens*, by peculiar Passages.

There's only one place in the *Testes*, where a certain number of Vesicles empty themselves: So that there cannot be more *Caruncles* than *Fertus's*.

The use of this Liquor is not question'd, after its mixture with a Man's; but when it comes into the Womb without mingling with Male-Seed, 'tis not very plain what use 'tis for then.

I conjecture, that this Seed being shut up in the *Ducts* for the space of a Month, or thereabouts, becomes sharp, and turns out of its Ducts, without exciting any pleasure, but with a great deal of heat. Then it opens the Vessels, and occasions a Flux of Blood, which is not different from that which circulates in the rest of the Body; but becomes sharp by mixing with this ferment.

Upon this Hypothesis, the following *Phænomena* want to be resolv'd: 1. Why the Females of other Animals have not their Terms? 2. Why the Terms anticipate their Time, when Women are possess'd with a violent Fit of Love; and if the Amour continues, why the Terms cease, and the Women turn pale? 3. How it comes to pass, that they usually commence at fourteen Years of Age, and go off at fifty? 4. Why Big-belly'd Women are not usually purg'd that Way? 5. Why the Maids that have not their Monthly Course, are commonly unhealthy?

To all these Questions, I answer: 1. In dissecting most Females of other Animals, we find that

the extremity of the Blood-Vessels of the Womb, is guarded with little Glandules ; which hinder the ferment of the Seed to operate upon 'em so as to open 'em, and suffer it only to heat 'em a little.

2. When a Womans Mind is fix'd to a beloved Object, the Spirits insinuating into the fleshy Fibres of the Cisterns of the Seed, force it out, and mixing with it, put it into a Fermentation, and so qualify it for opening the Blood Vessels of the Womb: But if these amorous Thoughts continue without intermission, the Seed being too often discharg'd, is not able to gather a sufficient quantity, or to acquire sharpness enough for producing the Terms. And thus 'tis, that amorous Girls want their Terms.

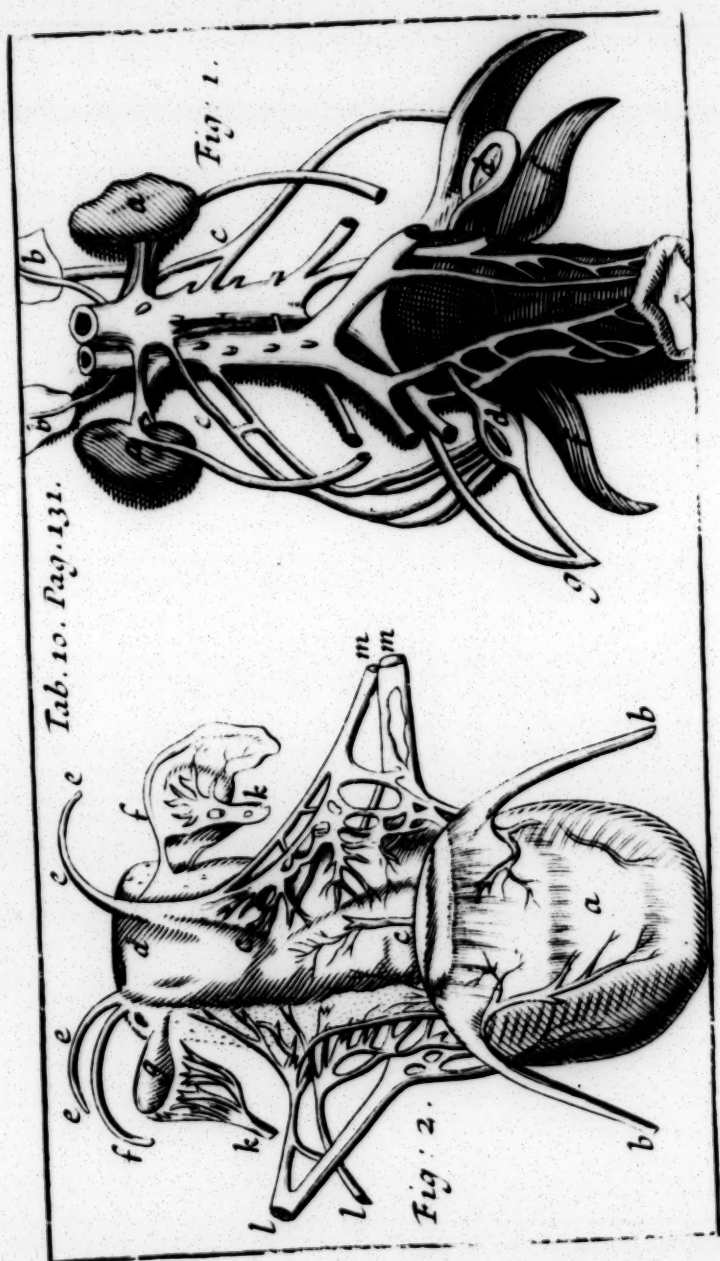
3. Before the fourteenth Year they cannot have Seed that will acquire a sufficient sharpness ; and accordingly we find, that Love, which is one of the Effects of that Liquor, takes its date from that Year. At fifty Years their Seed is stripp'd of its active Particles, and consequently unable to produce its wonted Effects. In explaining this *Phænomenon*, we cannot have recourse to the Scarcity of Blood, for they are oftentimes oblig'd to let Blood before Fourteen, and after Fifty.

4. When Women are with Child, there's always one of the *Tube*, and sometimes both, stopp'd by the *Placenta* : So that the Ferment not being able to repair in so large a quantity to the bottom of the Womb, cannot open the Vessels. Besides, part of their Blood is employ'd in nourishing the Infant.

5. When the Seminary Vessels are stopp'd up by Obstructions, commonly the Seed growing sharp returns to the Blood, and corrupts it, and occasions all the Disorders that attend the Maids that want their Monthly Course.

I said before, that when a Woman is tickled in
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those Parts, the *Clitoris* is fill'd with Blood, and its Muscles being swoll'n, bear down upon the Nervous Bodies and their Veins, and by that means stop the Blood that was carry'd in by the Artery.

I will not touch upon the use of the external Parts; only by the Bye, 'twill be proper to enquire, Why the Jewish Women were oblig'd to have the Linen tainted with Blood, the first Night of their Marriage? They marry'd their Males at a great Age, and their Girls very young: A Husband was not allow'd to see his Wife, but at a convenient distance, from the time of her Purgation. Now since the Bridegroom had a very large Member, and the Bride a very Fruit one, with her Vessels full of Blood; 'twas in a manner impossible, but that the Veins and Arteries should burst in the Adventure, and bleed. To which we may add, that the Country being very dry, the Girls must have been very thin.

On the contrary, in *France*, the Girls are more advanc'd in Years when they marry; and for the most part they are not nice in avoiding the time of their Terms: And by consequence, a Flux of Blood will not always ensue, notwithstanding that they are Virgins.

TAB. X. Fig. 1. From *Bartholin*.

Representing the Parts of a Woman turn'd up, with the Vessels and principal Parts joining to them.

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|------------------------------|--|
| aa. The Kidneys. | c. The Fundus, or bottom of the Womb.) |
| bb. The Capsulæ Atrabiliaræ. | ff. The broad Ligaments. |
| cc. The Spermatick Vessels. | gg. The Tubæ, or Trumpers. |
| dd. The Testes. | h. The Vagina. |

Fig. 2. From *Casseri*.

Representing the Womb taken out of the Body.

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|----------------------------|--|
| a. The Bladder. | hh. The Vasa Deferentia opening into the bottom of the Womb. |
| b. The Ureters. | ii. The broad Ligaments. |
| cc. The Vagina. | kk. The preparing Vessels. |
| d. The bottom of the Womb. | ll. Some Branches of the Nerves. |
| ee. The round Ligament. | mm. Some Blood-Vessels. |
| ff. The Tubæ. | |
| gg. The Testes. | |

C H A P. XIII.

Of some particular Secretions.

I Said before, that most of the conglomerate Glandules, have Ducts or Pipes peculiar to themselves; for instance, the Liver has the *Cholodochus*, the *Pancreas* that of *Virfungus*, &c. And that the conglobate Glandules have Lymphatick Vessels, which rise out of a small Slit in the Glandule. These Observations do not always hold, for the *Thymus*, which can be nothing else but a conglomerate Gland, has Lymphatick Vessels, and no other Excretory Ducts. And on the other hand the Testicles, which in Men are certainly conglobate Glands, have peculiar Ducts.

Tho' the conglomerate Glandules have peculiar Ducts, they have nevertheless Lymphatick Vessels; for Example, in the Liver, besides the Biliary Vessels, there are Vessels that carry the Lymph to the Cistern. 'Tis true, they seem to come either from its Membrane, or from the neighbouring conglobate Glandules; for we meet with Lympheducts, in Parts that have no Glands; and in that case, we conjecture, that the Membranes filtrate the Lymph, since their Contexture is closer, and their Pores more compact; and 'tis probable, that the Blood passing from the small Arteries into the Veins, easily quits its Serous Parts: So that when we find no Glands in some places, such as the *Pericardium*; that ought not to scare us from attributing the Filtration of the contain'd Liquors to the Membrane.

Having discours'd of *Filtration* in general; we are now to examine some particular Filtrations: Such as those of the Spittle and Milk.

As for the Spittle, it might be taken for the *Saliva* thicken'd either in the *Amygdala*, or in the *Pharynx*; and afterwards thrown out with force by the pressure of the neighbouring Muscles. I was long of that O-

pinion

pinion; observing that a Drop of Water in the Wind-pipe caus'd such violent Pains, I could not imagine that a thick glutinous and viscous Spittle, would occasion no inconvenience.

Having examin'd this Matter very maturely, and reflected upon the great number of Glandules with which the inner Coat of the Wind-pipe is clad, and with which the Lungs might concur; I concluded, that sometimes in a violent Cough the Spittings might come from the *Lungs*, and the *Trachea*: That while they lay still in those places, they occasion'd neither Pain nor Cough, both, because their Membranes are accustom'd to it, and because the Flegm is not so cold and penetrating as Water; that as the Air causes Pains in the Stomach without incommoding the Lungs, so Water excites a Pain in the Lungs, but none in the Stomach; and that the Matter of the Spittings, offends neither the *Trachea*, nor the *Ventricle*, unless its quantity be very great.

The Spittings are thrown up, by reason that the fleshy Fibres of the Wind-pipe contract it, and squeeze that Juice out of the Glands; upon which the Air, being expell'd the Lungs with force, sweeps that Matter along with it. This Matter can have no use, unless it be to defend the Coats of the *Aspera Arteria*, from the Corrosive Parts of the Air.

The Milk is strain'd out in the Breasts, which are two great conglomerate Glands: For these two glandulous Bodies are compos'd of several Glands which are furnish'd with Excretory Pipes, that terminate in the Nipples. These Nipples are porous Bodies, in which a great many Nerves terminate; upon which account they have a very tender sense, and grow hard upon a gentle tickling. The Breasts are supplied with Nerves from the Intercostal Nerve, external Arteries from the Axillary Artery, internal Arteries from the Subclavian Artery; external Veins terminating in the Thoracick Vein, and internal Veins open-

ing into the Subclavian Veins. They have likewise Lymphatick Vessels, and Excretory Duets to carry off the Milk.

It has been long debated, Whether there is any Communication between the *Thoracick Duets* and the Breasts. But since a passage for Communication has been narrowly sought after, but never found, I think we ought not to suppose any such thing; especially while the Generation of Milk may be accounted for without it. I take it to be done in this manner:

The Milk is separated from the Mass of Blood; for tho' we can say, that all Filtrations are not performed by Glandules, yet we cannot say that there's any Glandule but what filtrates its Liquor out of the Mass of the Blood: Now, the Breasts being all over glandulous, 'tis probable they separate this white Matter from the Blood, it being the same with what we find in the *Amnios*. And indeed, I take that to be the Original of both the one and the other.

The *Chyle* circulates for some time with the *Blood*, without being exactly mix'd with it; so that when it passes into the Glands of the Breasts, or to the Membranes of the *Amnios*, 'tis easily separated. But there remains this Difficulty to be remov'd, *viz.* Why that Juice is never strain'd out into the Womb, but in the time of Gestation; nor into the Breasts but after Childbirth.

First of all 'tis to be consider'd, that this Liquor is not separated from the Blood, neither in the Womb, nor in the Breasts, before the Woman is with Child. So that about that time, there must be something that alters the Structure of the Womb, and the Breasts. Indeed, 'tis a hard Matter to tell what it is, that changes the Constitution of these Parts, and how the change is brought about. Several Schemes may be invented, which are all possible; however, I present you with one, which seems to be very clear and plain. At the time of Conception, as I take it, the Parts of the Seed get into the Cavity of the Womb,

Womb, and creep into the Pores of its Membrane, which they open by their activity : By this means, the Holes that were formerly too little, are now made large enough to receive the Chylous Parts ; and at last the Volatile Parts of the Seed circulate along with the Blood, and make some small dilatation of the Pores of the Breasts. But the greater impression being made upon the Womb, and consequently its Pores being large enough to receive all the Chylous Parts, they make but weak Efforts upon the Pores of the Breasts. And upon that account they are not filtrated in the Breasts, but when the Womb cannot receive all that Juice, or when the Pores of the Breasts are extremely dilated, as it happens to Nurses ; or else (as *Hippocrates* says, § 5. *Aph.* 52.) when the *Firtus* is weak, whether it be that all the necessary Aliment do's not move to the Womb, or that the impression made by the Matter is not strong enough to influence all the Chyle, the Child being form'd of unactive Seed, and so not able to exert its due force. When the Pores of the Breasts are shut, the Chyle runs to the Womb ; and when those of the Womb are shut, it is filtrated in the Breasts ; by reason of their mutual conformity.

But after all, these Rules are not always true ; since we have many Instances of Girls that have Milk, and yet are so far from having had Children, that they never knew Man ; and of Men that void at their Breasts a Liquor not unlike to Milk.

CHAP. XIV.

Of the Nourishment of the Parts.

WHEN a Man has form'd to himself a clear Idea of the Oeconomy of the Body, the Nature of the Humors that circulate in it, and the different Preparations they undergo ; one would think he might easily see how the Parts are nourish'd. 'Tis

true, all those things are more known now, than they were before. But after all, 'tis certain, that we are not yet acquainted with all the Springs employ'd in that Function. This 'tis that renders the Matter difficult, and almost impenetrable.

It may be said in general, that we are nourish'd with the Aliment; that its fine and subtil Parts, after some preparation in the Stomach, are convey'd by the *Lactææ* to the Glands of the *Mesentery*; from whence they run to the Secondary *Lactæals*, and from thence to the *Cistern* and *Thoracick Duct*, and after that to the *Subclavian Vein*, where they mix with the *Blood*, and circulate with it, 'till they become Blood it self. But after all, tho' we know that this Blood consists of a fibrous and a serous part; that there are little Globes, or Balls, of different Figures, that float in a transparent Liquor, and that the Blood is compos'd of sulphureous and nitrous parts; 'twill still be very hard to adjust exactly the Nutrition of every part.

One may say, for instance, that every part of the Body has Pores proportion'd to the Figure of such Parts of the Blood as 'tis to receive: But that does not determine the Bulk and Figure of the Particles, with which such and such Parts are nourish'd. Nay, even our general Knowledge is attended with several difficulties; for the question may be put, how the *Corpusculums* of Blood make the Parts grow every way; why the Body grows more in length than in thickness; and how 'tis, that the same Blood nourishes the fleshy and the bony Parts?

'Tis to be consider'd, that the Particles of the Liquors circulating in the Body, may be able to insinuate themselves into the Pores of the Parts which are stripp'd of some before. And that indeed explains the continual Reparation of the Waste; but do's not account for the limited Growth of the Body, and its usual Confinement within the 25th Year of one's Age, &c. The unriddling of these *Phænomena* is a very difficult Task, and *Anatomists* have pursu'd the Discovery with little Application.

Before

Before the Discovery of the Course of the Humours, 'twas thought, that the Chyle was suck'd in by the Mesaraick Veins, that the Liver suck'd it again from the Veins, and after that every part suck'd out of the Liver what was proper for it : And then that this Liquor so drawn in, run down upon the Parts like Dew, and by Virtue of its stay was glew'd to 'em, and at last transform'd into the substance of the Parts. This Opinion is so ridiculous, that if such an one were broach'd now-a-days, no Body would give themselves the trouble to refute it : But in regard of the Authority of its Votaries, Authors have taken the Pains to make out the uselessness of attractive and assimilating Faculties.

As soon as the Course of the Humours in the Body was discover'd, this Opinion was rejected : But others were embrac'd, that were equally false, tho' more intelligible. Some *English* Authors fancy'd, That the Blood is not the only Nourishment of the Parts, but that part of the Chyle ascends to the Brain, by the Branches of the Nerves of the Eighth Pair ; and from thence is convey'd by the Nerves all over the Body, in order to nourish the Parts, by mixing with the Blood. The chief Motive to this Opinion, was, the withering and decay of such Parts as have their Nerves stopp'd up in some Diseases. But after all, that Opinion cannot stand, if we reflect on the Course of the Chyle, and consider, that the Nerves have no sensible Cavity, nor any Juice. Their Proofs amount to no more than this, that the *Nerves* assist in the Business of Nutrition ; which is not contradicted by the common Opinion, for that supposes that the Animal Spirits dilate the Pores of the Parts, in order to give admission to the Particles of Blood.

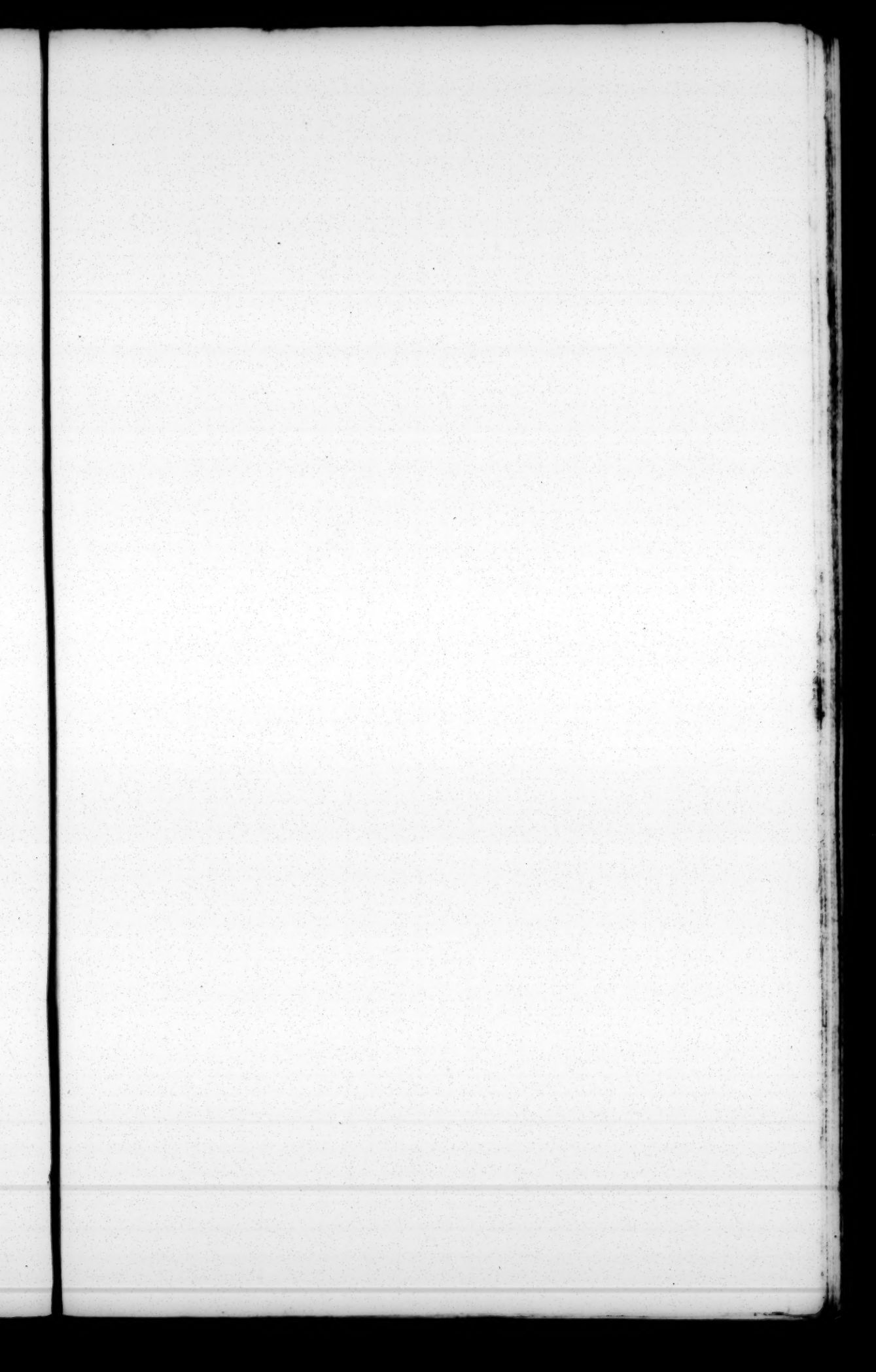
Some modern Physicians alledge, That the fibrous part of the Blood adhering to the Fibres of the Parts, enlarge their bulk. The plainness and simplicity of this *Hypothesis* would recommend it, if it did but account for all the *Phænomena*. But how should that
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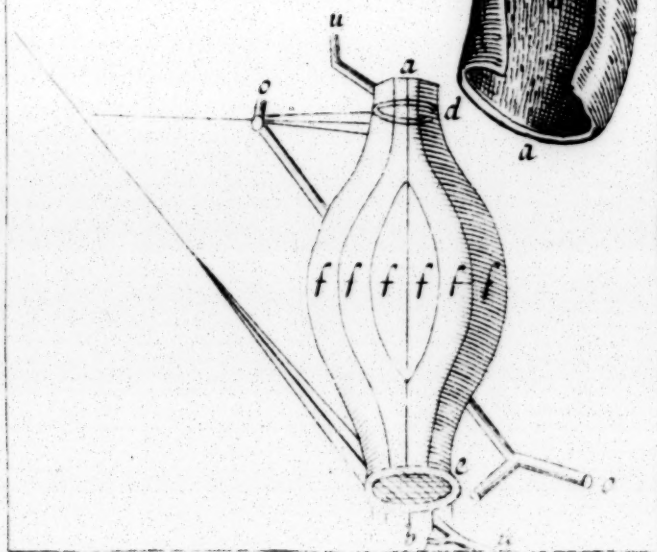
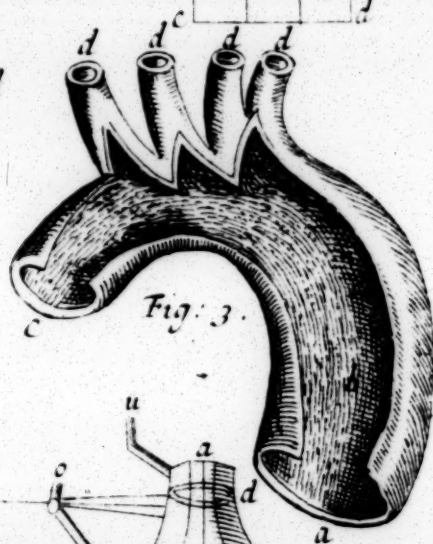
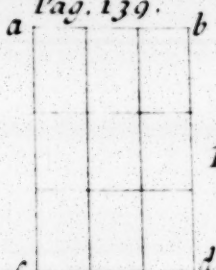
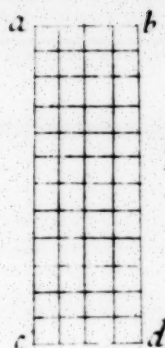
homogeneous part nourish so many different Parts, and why do's it not continue to enlarge their size, after a certain Period of Years? &c.

Some other Moderns give in the Chyle for the Matter that immediately nourishes the Parts. They endeavour to fortify their Opinion, by the balmy and nourishing Quality of that Humour, and its not being converted into Blood, 'till after several Circulations. But this Opinion is incumber'd with the same Difficulties as the former. Besides, the Chyle begins to receive some Modifications of Blood, as soon as their Joynt-Circulation commences.

To my Mind, we ought to single out certain Parts of the Blood, for the nourishing of certain Parts of the Body. And therefore I cannot be perswaded that the viscus Part nourishes all the Parts, no more than the Lymphatick: But I can readily believe, that either of 'em nourishes Parts that have different Pores. I grant likewise, that both these Parts of the Blood may nourish the Body, since its Parts are capable of a certain extension, which accrues to 'em insensibly from the Juices that flow into 'em, the Particles of which insinuate themselves among their Fibres. Furthermore, as I take it, the Body is compos'd of Fibres, and these Fibres of little Cells, which swell both in breadth and length, but still retain such Dimensions as bear a proportion to those it had at first. For instance: If the Fibre of any part that runs lengthways, such as *ac* (in the *Fig. 1. of Tab. XI.*) contains thrice as many Cells, as the Fibre *ab* which makes its breadth: and if all these Cells are equal; supposing that every Cell is enlarg'd to one half more, as well in the Line *ab*, as in *ac*; then I say, the part will still have thrice as much length as breadth, and consequently, that the Body grows proportionably both in length and breadth.

On the other hand, if the Cells of the length, and those of the breadth were unequal, and if the length had no more Cells than the breadth; it would follow,





low, that each Vesicle would grow equally in breadth and length; and that if the Part *ad* (Fig. 2. Tab. XI.) has six Inches of length, and three of breadth, and happens to grow an Inch in length, it would grow as much in breadth, for every Vesicle would be equally swoll'n; and at that rate the part would have seven Inches of length, and four of breadth; in which case the former proportion would be sunk, since at first 'twas just as long again as broad. So that upon the whole, we must suppose, that there is a greater number of Cells in the length than in the breadth.

After a certain number of Years, the Body grows no more, by reason that the Parts grow hard, and the Cells are not extendible, especially in hard Parts, such as Bones; and by consequence, since the bony Parts are at a stand, the Body cannot grow in length after that; tho' at the same time the fleshy Parts may increase their bulk, and so enlarge the breadth and thickness of the Body.

T A B. XI.

Fig. 1. and 2. relate to this Chapter. Fig. 3. to the First Chapter of the Second Part. And Fig. 8. to the Fifth Chapter of the Second Part.

Fig. 3.

- a. The part of the Aorta that was united to the Heart.
- b. The Trunk of the Aorta laid open.
- c. The descending Aorta.
- d. The ascending Branches.
- e. The small Borders at the entry of the ascending Branches.

C H A P. XV.

Of the Nutrition of the Membranous, Tendonous, Cartilaginous, and Bony Parts.

IT has been advanc'd by some famous Anatomists, that the Membranous Parts, the Cartilages, and the Bones, differ only gradually from one another. They ground their Sentiments upon this; that the Membranes become Cartilaginous or Gristly, the Carti-

Cartilages harden into Bones, and the hardest Bones in a Man, are but Cartilages in a *Fetus*.

As for the Tendons, they make a Remark, that several Muscles have no other Tendon but the Body of the Bone it self; and that several Tendons are ossify'd; as may be seen in the Muscles that run along the Thighs of Fowls. But their principal Argument is, that the Tendons are nourish'd with the same Juice as the Bones: For the Juice that runs from a wounded Tendon, is like to that of a broken Bone. These Juices are pretty glutinous, and condense into a sort of a Jelly.

I am of the Opinion, that the Matter which nourishes the Membranes, Tendons, Cartilages, and Bones, is much of a like nature. But at the same time, I doubt, if it has the same disposition of Parts. The tender sense of the Tendons and Membranes, and the insensibility of the Cartilages and Bones, vouch for a difference. 'Tis true, when the Tendons are ossify'd, they lose their Sense; but then they are likewise depriv'd of the former disposition of their Parts. Now the difference of this disposition, or ranging of the Parts, consists in two things: 1. The Bones and Cartilages are less fibrous. And, 2. Their Parts are more close and compact, than in the Tendons and Membranes.

But this difference do's not prove, that the Juice which nourishes these Parts, is not the same, or at least has Parts like one another. When, I say, the Parts of one Matter are like those of the other, I mean in figure, not in thickness: For 'tis possible the hardness of the Bones may proceed from this, that the Parts which nourish and compose 'em are smaller, and consequently leave smaller Intervals between 'em, which is one of the first Principles of Hardness.

The Liquor that nourishes the Bone, is conducted thither by the Arteries, that water the *Periosteum*: But a perfect Knowledge of this Matter cannot be compass'd, without having an *Idea* of the Structure of all these Parts.

The

The Bony Fibres are so dispos'd, that they receive only a Lymph impregnated with Salts, and turn back the rest of the Blood by the Vein. After this Lymph has circulated in the Fibres of the Bone, it repairs to the Lymphatick Vessels, or else to the Veins. In the mean time, some parts of this Lymph may stick to the Fibres of the Bone, sooner than in any other part; because they are not hinder'd to settle there, since their Oily Parts are separated from 'em, and lodg'd in the Cells of the Marrow. This Marrow softens the Fibres of the Bone, and fetters the saline and sharp Parts of the Lymph, that otherwise might make too great a head: And this 'tis, that makes the Bones and Cartilages supple.

The Bone begins to harden in the middle; and that for several Reasons: 1. The Bony Fibres, which lie at a distance from another all over the Bone, are drawn nearer together in the middle; so that when each Fibre begins to harden, the hardness will appear soonest in that part. 2. Each Vesicle in the middle of the Bone is more press'd by the other Vesicles, for a greater number of Vesicles surrounds it; and pressure is one of the principal Causes of hardness.

Tendons are Bundles of Nervous Fibres, seated in the head and end of every Muscle. Their Fibres lie very close, upon which Account 'tis, that they receive only the Lymphatick part of the Blood. I am apt to believe, that the Tendons, by dilating themselves, produce not only the Membranes call'd *Apo-neuroses*, but likewise all the Membranes of the Body; that is, that their Fibres are continuous to all the Membranes.

At the extremity of the Bones, we meet with two sorts of risings, one sort continuous to the Body of the Bone, and the other only contiguous. The former are call'd *Apophyses*, and the latter *Epiphyses*. I shall not enter into the detail of these Matters, because they are of little use, and generally known.

In every Bone we descry two *Lamelle*, or *Surfaces*, one external, and another internal. Betwixt these, there lies a prodigious number of little Cells, which are all over very perceivable ; but much more so, towards the Extremities of the Bones, where they are larger. I wave the Articulations, Cavities, Holes, Pits, *Sinus's*, &c. of the Bones ; designing to fetch in elsewhere whatever is considerable upon those Heads.

C H A P. XVI.

Of the Nutrition of the Muscles, Vessels, and Glandules.

THE *Muscles* are a Collection of fleshy Fibres wrapp'd up in a Membrane ; furnish'd with Veins, Arteries, Nerves, and Lymphatick Vessels. Their Fibres are so many, that those of the Body of the Muscle make a *Parallelipipedum*, with *Oblique Angles*, and every *Tendon* makes a *Quadrangular Prisma*. This Discovery we owe to *Steno*.

In the Body of the Muscle, the Fibres are fleshy ; and towards the Extremities tendonous. Every tendonous Fibre do's not make a straight Line with the fleshy part, of which it is a continuation ; but an Angle, which corresponds to that made by the same Fibre at the other tendonous Extremity. These Fibres are rang'd in several Plans, each of which makes an *Oblique Angl'd Parallelogram*, or a *Rhomboides*. Now the several *Parallelogram*, being laid one above another, make a *Parallelepipedum*, which we call a *simple Muscle* ; and several Muscles joyn'd together, and inclos'd in one common Membrane, make a *compound Muscle*. I shall not enlarge further upon the Structure of a Muscle, since I am not now to treat of its Action : 'Twill be sufficient to hint in a few

few Words, at the Composition of its Fibres.

M. *Lewenboeck* observes, that every fleshy Fibre is compos'd of very fine small Vesicles, fill'd with a clear and transparent Liquor, that the Vesicles of the external Parts of the Fibre seem to be round, and that he could not distinguish the rest, because they were heap'd one above another. These Vesicles are certainly very little, since five or six hundred of 'em together do not equal the thickness of a Hair of a Perriwig: And consequently they require a nice Microscope in the Hand of a diligent Observer. From these premises, we may conclude, that when all the Vesicles of which the Muscle is compos'd, are swell'd and enlarg'd every way, the Muscle will increase proportionably in length and breadth. Now these Vesicles are blown up, when the quantity of the Liquor increases; and when they are swell'd, their Contexture is firmer and closer. 'Tis likewise probable, that all these Vesicles open into one another, and convey a great part of the Blood from the Arteries into the Veins, or Lymphatick Vessels: So that they may serve for Pipes of Communication between these Vessels.

We may also suppose, that the Nerves retaining to the Muscles, surround, and oftentimes straiten the Extremities of the fleshy Fibres: So that sometimes a great pressure is requisite to make the Liquor pass from the Artery to the Vein.

The Blood that passes thro' the Fibres of the fleshy Vesicles, leaves some fibrous Parts upon 'em, which serve for the Nutrition and Enlargement of the Muscles.

As for the *Glands*, we have examin'd 'em already, as being the principal Instruments of Secretion. 'Tis needless to repeat their Composition. And in regard we shinn'd 'em to be Vessels folded and winded up, 'twill be proper to explain the *Nutrition* of the Vessels, before we touch upon the Nutrition of the Glands.

We

We meet with small Arteries in the great Trunks of the *Aorta*, which are lost in its Membranes ; and without doubt, 'tis by them that it is nourish'd. But where are the Vessels that feed the Membranes of these little Arteries ? Must we go *in infinitum* with them ?

I answer, That we may suppose, that the Membranes of these small Arteries are nourish'd by the Parts of the Blood, that fall off to the right and left, and continue in their Pores ; and that all Vessels that have not so thick a Coat, are so nourish'd ; particularly all the Capillary Vessels, and by consequence the Glands, which are only a Clew of them.

As for the Excretory Vessels, they have some Arteries that furnish 'em with Nourishment.

We find Arteries also in the Nerves, which furnish a Juice that nourishes the Nerves, much after the same manner as the Tendons and Membranes. Some have fancy'd, that this Juice comes from the Grand, as being filtrated there by the Glands ; and accompanies the Spirits in the Nerves, both to prevent their dissipation, and to feed the Parts of the Body, by mixing and fermenting with the Blood. 'Tis possible indeed, that the Glandules of the Brain make some filtration ; but we are not sure of it : And besides, 'tis not probable, that so small a quantity of Liquor as must be filtrated there, will serve to nourish the Parts of the Body ; or that the Nerves which have no sensible Cavity, should carry a sufficient quantity to these Parts.

Besides, 'tis to be observ'd, that the Juice that runs from a Tendon, or a broken Bone, is not the Nervous Juice ; for the former runs in great plenty, whereas the other will scarce afford a few Drops. It remains therefore to be concluded upon, that the Bones, Tendons, and Membranes, filtrate the Juice that feeds them, and do not receive it from the Nerves.

The End of the First Part.

PART II.

Of Sensation, and of Voluntary Motions.

CHAP. I.

Of the Ascent of the Blood to the Brain.

THOUGH the forming of the Chyle and Blood, and their different preparations, may seem to lie remote from the business of Sense and Motion; yet all these different actions are so ty'd together, that the latter cannot be explain'd without an entire knowledg of the former. 'Tis true, there is a great deal of difference between the Generation, or growth of the Body, and the Motions that ensue upon the shaking of our Organs; But 'tis equally certain, that both the one and the other depend upon the Blood, as one common cause. Generation requires the conveyance of the Blood to the Testicles, and Motion supposes the ascent of the Blood to the Brain. Before we proceed in this matter, 'twill be necessary to shew how the Blood can ascend.

The *Aorta* springing from the left Ventricle, sends out a branch that encompasses the substance of the Heart: after that it bends into an Arch, the upper part of which detaches several branches. At the head of these branches, within the Arch we meet with a Cartilaginous border, that hinders some part of the blood to descend in the

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bending of the *Aorta*, and obliges it to ascend in the branches that lead to the Head.

The Artery is dilated by the blood that rushes from the Heart with a great Current; and after that, contracts it self by vertue of its rebounding spring.

'Tis observ'd that the *Carotides*, in their ascent to the Head, divide themselves into the *External* and the *Internal*. The first visit the External parts of the Head; but the Internal, having pass'd thro' some holes of the Skull, as well as the *Vertebrales*, make, as they do, some turns and windings, which break the impetuosity of the Blood, and so prevent the injury that might accrue to the Cortical part of the Brain, by too great a separation or breaking of its parts.

The thing that deserves most to be remark'd, is the communication of these Arteries: For the *Carotides* have branches for Communication; and in the like manner, the *Vertebrales* are joyned by an Arterious Pipe. Besides, the *Carotides* have some branches, by which they communicate with the *Vertebrales*: So that if three of these vessels were stop'd, above these uniting Pipes, the remaining one would supply all the parts of the Brain.

CHAP. II.

Of the External Parts of the Head.

THE outermost coverings of the Head, are the Hair, Skin, Fat, and Flesh; but since these parts are common all over the Body, 'tis not proper to treat of 'em in this place: I shall therefore proceed to examine the bony case, that encloses the Brain on all sides.

This

This Bone, which we call *Cranium*, is strong, hard, and round. It has two Prominences or Risings, one before and another behind. On the sides 'tis a little flattish. 'Tis compos'd of several pieces, which are united by *Sutures*: It has two bony *Lamella's* or *Plates*, one without and another within; between which there are several Cells fill'd with a Marrowy juice, call'd *Diploe*. The outer *Lamella* is covered, as well as all the Bones in the Body, with a fine sensible Membrane, which in that part is call'd *Pericranium*, and every where else *Perosteum*.

All the abovementioned qualities of the Skull, contribute to the better preserving of the Brain, and screening it from external Injuries. For the Coverings break the shock of blows, the *Pericranium* makes 'em to be sooner perceiv'd, and the *Cranium* being hard receives and bears the blow. Its roundness augments its strength, for a circular Figure is stronger and more capable to withstand Attacks from without, than another; for its surface being larger without than within, it makes a sort of a Vault, that is not so easily broke or sunk.

The Skull being compos'd of several pieces, is more capable to resist external efforts, by stretching it self; and its fractures must terminate in the *Sutures*. The medullary substance lodg'd between the two Plates, keeps the fractures of the outer Plate from communicating themselves so easily to the inner one.

Its flatness on the sides, gives us to know that the Eyes are more capable to spy whatever may be deem'd offensive.

The *Diploe*, besides the above mentioned use, contains a Medullary juice, that softens the bony Fibres, and nourishes them, or disposes 'em for receiving nourishment. But without insisting fur-

ther on the uses of the parts of the Skull, we come now to take a narrow view of its Structure.

The pieces of the Skull are joyn'd by *Sutures*. There are some junctures of the Bones of the Skull, with those of the Face; and some of the Bones of the *Cranium* only with one another: These last mentioned are either *True* or *Counterfeit*. The *True* are a close union and deep indenting; so that nothing appears but a line resembling two Saws joyn'd by their teeth. The *Counterfeit* take place when a Bone is only laid upon another, like the scales upon Fish, as in the Temple-Bone. 'Tis true, some Anatomists have offer'd to prove that these *Sutures* are also ingrail'd; but still they resemble scales laid one upon another, and therefore ought to be rank'd in a particular form.

There are three *true Sutures*, viz. the *Coronalis*, *Sagittalis*, and *Lambdoides*. The *Coronalis* terminates in the Temple-bones, the *Sagittalis* joyns the two bones on the Crown of the Head; the *Lambdoides* distinguishes the bone of the hind-head from those of the Crown.

There are two *Common Sutures* between the bones of the Skull and those of the Face: One surrounds the *Os Ethmoides*, and the other encompasses the *Sphenoides*.

Some add a *transversal Suture*; but 'tis only a continuation of the *Coronalis*.

The things to be considered in the bones of the Skull, are their Figure, their Situation, their *Apophyses* or Processes, their *Sinus's*, and their Perforations or Holes. The first Bone is that of the Fore-head, called *Frontale*. 'Tis thicker than the bones of the *Synceput*, but thinner than that of the *Occiput*. It has two Cavities, the Structure of which shall be survey'd under the head of Smelling: It has likewise a rais'd Process, which makes the upper part of the *Orbita*, or circle of
the

the Eye; and is called the *Spina* of the *Os frontis*: Within this bone there are two Pits.

The bones of the *Syncyput*, or Crown of the head, are of a square Figure; they are joyned by the *Sutura Sagittalis*, and distinguish'd from the *Os frontis* by the *Coronalis*, from that of the *Occiput* by the *Lambdoides*, and from the Temple-bones by the Counterfeit *Sutures*. These bones are so soft in Children, that the Pulsation of the Arteries leaves their impression upon 'em.

The bone of the *Occiput* or hinder part of the Head, joyns those of the *Syncyput*, the Temple-bones, and the *Sphenoides*. On the inner side it has a small rising, call'd the *Spina*; on the outer side it has two more, by which it is Articulated with the first *Vertebra*. It has two Pits that hold the *Cerebellum*. It has likewise some holes, the greatest of which gives passage to the pith of the Back; and the smaller ones receive some Nerves and blood Vessels. The *Temple-bones* shall be consider'd under the Head of *Hearing*.

Having consider'd the proper bones of the *Cranium*, we come now to treat of those common to it and the face; viz. the *Sphenoides*, and the *Ethmoides*; the last of which will come in under the Head of *Smelling*.

The *Sphenoides* makes the Basis of the Skull; it has several perforations or holes for the ingress and egress of Vessels. It has eight *Apophyses* or Processes; four without, and four within. Of the External Processes, some lie forwards, some backwards: the two fore ones are almost like *Bats-wings*; The back ones joyn their extremities towards the *Styloides* Process. A fifth has been observ'd to rest in the *Os jugale*.

The Internal Processes may be justly compared to four small ends of Columns: They and the intervening space make the *Sella Equina*.

The general use of all these bones, is, to contain and secure the Brain; Their Pits are only calculated for receiving the Prominences or Rissings of the Brain; and their holes are made for the Passage of the Vessels that come and go. Most of the abovemention'd *Apophyses*, serve to support some Muscles that rest upon 'em: Of which more anon. Their *Sinus*'s are employed to contain part of the *Membrana Pituitaria*.

CHAP. III.

Of the Parts contain'd in the Skull.

UNDER the *Cranium*, there are two Membranes that encompass the Brain. The outer one, called *Dura Mater*, is very hard and thick; It enjoys a prodigious quantity of bloody Vessels, but has few Nerves, for its Nerves are scarce perceivable, Notwithstanding that its sense is very tender. Its upper part is doubled, and the duplicature (which we call *Falx*) divides the Brain into two. This Membrane so folded back is strongly extended, and withal fastened to the neighbouring Bones; so that, when one lies on the side of the Head, the upper part of the Brain does not bear down upon the other. The same Membrane is doubled in another place, and separates the Brain from the *Cerebellum*; and this last duplicature is stretched out as the first, and when one lies on the hinder part of the Head, defends the *Cerebellum* from the pressure of the Brain. In some Animals this duplicature is bony. Besides the abovementioned use of preventing the pressure of one part of the Brain upon another: I guess these duplicatures may serve for all-

another, viz. to be as so many fixed points in which the fleshy Fibres of the *Dura Mater* are inserted. These fleshy Fibres are of use to squeeze the *Cortical substance*, and pass the liquor it has filtrated into the white substance. This Opinion will be readily entertained, if we call to mind, that I prov'd, that the Membranes which degenerate into Bones are tendonous; insomuch that 'tis very probable, that all these duplicatures are so many tendons in which the fleshy Fibres of the *Dura mater* terminate: For, tho' our Senses cannot discover that this Membrane is Muscular, yet we ought to make such a Conjecture, because there are no tendonous Fibres without fleshy Fibres. By this *Hypothesis*, we may easily explain, how it comes, that one drop of blood shed upon the *Dura mater*, raises Convulsions all over the Body? Whether it be, that by vertue of its own Spring, it squeezes the Brain hard, and expels the Spirits into the Nerves; or that by agitating the head of the Nerves, it puts all the Body into extraordinary Motions: For, 'tis well known, that when a Tendon or a Nerve is provoked or fretted, the Muscle shrinks, and contracts its self, and oftentimes by vertue of the Communication of the parts, throws the Neighbouring Muscles into Convulsive Motions.

We find several Cavities or *Sinus's* in the *Dura mater*, which receive the blood from the Arteries, either immediately by plain *Anastomoses*, or by the Veins springing from the Glands and neighbouring vessels. These Cavities empty themselves into the *Jugular* and *Vertebral* Veins, which forward the blood to the Heart.

The Ancients, who were Nice enough in distinguishing such Parts as were very obvious to the view, observ'd four *Sinus's*. One goes lengthways along the upper part of the first duplica-

ture, from the fore to the hinder part of the Head. At its extremity backwards, there are two others reaching to the sides of the *Cerebellum*, which are call'd *Lateral*; and after being turned round and dilated in the form of a *Receptaculum*, empty themselves into the Veins. Where these three *Sinus*'s meet, there stands another, which dives pretty deep into the Medullary substance; and does not run much forwards, but receives some Veins: Of which, elsewhere.

This was the description of the *Sinus*'s of the *Dura mater* given in by the Ancients: To which we must add some modern Remarks.

1. The vessels that open into the *Longitudinal Sinus* are so rang'd in Men, that their insertion is quite opposite to the current of the Blood contain'd in the Cavity; for this runs from the fore to the hinder part of the Head, whereas the veins throw in the Blood from the hinder towards the fore part. But in those Animals which bend their Head towards the Ground, the Vessels that empty themselves into the *Sinus*, are inserted so as to go along with the current of the blood.

2. 'Tis manifest that the Vessels that open into that *Sinus*, creep along between the coats of the *Sinus*, before they open into it; much after the same manner with the *Ureters* in the Bladder. The Consequence of which, is, that the *Sinus* cannot over-load it self with blood, or receive more than they throw out; for a great quantity of blood would straiten the Orifice of the small vessels, and hinder their evacuation.

3. This is the only place of the Body, in which the Arteries have manifest *Anastomoses* with the veins; upon which account 'tis, that these *Sinus*'s beat like Arteries.

4. In the *Sinus* that runs length-ways we meet with little Stays or fleshy Fibres, which break

break the impetuosity of the Blood, and prevent the unseasonable distention of its walls.

Besides these particulars, unknown to the Ancients; The Moderns have likewise discovered other *Sinus's*, namely three very plain ones. The first of which runs along the lower part of the *Falx*, and opens into the fourth. And the other two terminate in the lateral *Sinus's*, rising about an Inch off from them, where the *Dura mater* makes its duplicature between the Brain and the *Cerebellum*. The discovery of these three *Sinus's* put other Anatomists upon a narrow search for more; and accordingly they have found out five that terminate in the *lateral Cavities*. Four of these rise from the Basis of the *Os sphenoides*, and the fifth from the *Crista* of the bone of the *Occiput*.

The use of all these *Sinus's*, is, to retain the Blood of the Veins and Arteries that open into 'em. The *Longitudinal Sinus* receives the blood of the Arteries, that water the *Dura mater*, and that of some neighbouring Veins; as also the blood of the external parts of the Face, conveyed to it by a venous Pipe that perforates the *Cranium* towards the Crown of the Head; upon which Consideration, *Willis* gives the contraction of the Fibres of the longitudinal *Sinus*, for the cause of the Redness of the Face that attends Blushing. This *Sinus* discharges it self into the side-cavities, as well as the Fourth which returns the blood of the inner part of the Brain, the *Glandula Pinealis*, the *Plexus choroides*, &c. The *Sinus's* at the bottom of the Skull, receive part of the blood of the Veins of the Eyes, the *Glandula Pituitaria*, the *Infundibulum*; and afterwards empty themselves into the side-*Sinus's*.

'Tis to be remark'd that all these *Cavities* are of a crooked winding form. Their Pulsation drives

drives a great many volatile parts into the Cortical substance, and from thence into the White substance. If the Arteries did not open immediately into them in order to communicate subtil blood, the blood might fall short of its due Motion in its return to the heart.

Here, we ought to observe with some Moderns, that the Circulation of the blood in the Head, must be somewhat perplex'd in two postures. The first of which, is bending, or hanging the head forwards, for then the blood of the *longitudinal Sinus* ascends, whereas it usually descends. The second, is lying on the back of the Head, and that somewhat low; for then the blood of the Jugulars ascends, whereas in other postures it descends.

After the removal of the *Dura mater*, we spy another fine tender Membrane, call'd *Pia mater*, which surrounds the substance of the Brain immediately, and conducts the Veins and Arteries to the bottom of its windings, by insinuating it self into the folds of its substance. *Willis* tells you this Membrane is clad with an infinity of Glands, but several other Anatomists have sought for 'em in vain.

We come now to the substance of the Brain, which is of two sorts, Namely, the external, Grayish, Ashcollor'd, and soft part, which is not quite half an Inch deep, and grows whiter as it deepens: And the inner white, and firmer substance. In the surface of the ashcollor'd substance we spy several windings like the circumvolutions of the small Guts.

Malpighi pretends that the ashcollor'd substance, is a collection of Glandules, each of which sends forth a string; and that all these Fibres gather'd into a Body make the white substance; and being after that more straitened, are formed
into

into Nerves: But, since these are unprov'd supposals, I shall only say, that the parts of the Cortical substance are less compact, and its Pores are more open; the former being evident from its softness, and the latter from its blackish color. To which we may add, that when we Syringe a Liquor into the Arteries, it only penetrates the Cortical part, without touching the Medullar.

The Brain is a Body compos'd of ashcollored and white parts. 'Tis divided into three parts; Namely, the *Cerebrum*, or Great Brain, the *Cerebellum* or Little Brain, and the *Medulla Oblongata*. The last of which, properly speaking, is nothing else but a production of the former two.

We observe, as I said but now, several windings in the surface of the *Brain*, and *Cerebellum*; by which the External surface of the Cortical substance is much enlarged, and by consequence is capable to receive a greater number of Arteries, than if it were plain and smooth: And 'tis easily imagined, that when the blood moves thus towards the Cortical part, and the pressure of the *Dura mater* promotes its entrance, a greater number of subtil parts will insinuate themselves into it, and pass from thence to the white substance, while the rest of the Blood, not being filtrated, will return by the Veins.

The *Cerebrum* is divided into two *Lobes*, by the first duplicature of the *Dura mater*: One on the right, and the other on the left-side.

At the lower extremity of this division, we find a white and pretty hard substance, which is called *Corpus callosum*; and to speak properly, is only the *Medullar substance* with its Fibres a little more compact.

Under the *Corpus callosum*, there are two Ventricles, one on the right, and another on the left, resembling a Half-Moon: They are only divided by a transparent Membrane fastened to the *Corpus*. These Cavities are usually filled with the *Serum* that is strained out by the Glands of the *Plexus choroides*, which lie at the bottom of these Ventricles.

Under that transparent Membrane that separates the Ventricles, stands a Process, commonly called the *Fornix* or Vault with three Pillars, tho' indeed it has nothing that resembles either a Vault or Pillars. One of these pretended Pillars stands forwards, and the other two backwards. Upon this Vault there's a Chink, that may be easily dilated, which discovers the third Ventricle that communicates with the fourth by a hole call'd *Anus*. The lower part of this Passage is called *Pons Varolii*. The third Ventricle has yet another Passage by which it communicates with the *Infundibulum*; which is a pretty broad Tube, seated under the third Ventricle; and terminates in a point at the *Glandula pituitaria*, which is situated in the *Sella* of the *Sphenoides*.

The two Protuberances towards the fore part of the Head, present us with an agreeable mixture of the Ash-collor'd and White parts, which are as it 'twere chamfred, and are call'd *Corpora Striata*. The second rising not far from these, are call'd *Talami nervorum Opticorum*, by reason that the *Optick Nerves* take their rise from thence. The third Protuberances, are from their Figure, called *Nates*. The fourth, being a little less than the former, are call'd *Testes*. The *Glandula Pinealis*, which is a Glandule as big as a Pea, is seated between the four last Prominencies, and ty'd to the *Plexus choroides*. So far, of that part of the *Medulla oblongata*, that is produc'd by the
Brain

Brain alone. The other Prominencies of which 'tis compos'd, are produced either joyntly by the Brain and *Cerebellum*, or by the *Cerebellum* alone.

The Ash-collor'd part of the *Cerebellum*, is much thicker than that of the Brain; and by reason of its being discontinued and interlaid with the White part, when it is cut, it represents Oak leaves. It seems a part of the *Medullar* substance of the Brain and *Cerebellum*, concur to produce the *Annular Protuberance*, which lies behind the *Testes* in the *Medulla oblongata*. After the *Annular Protuberance*, we meet with other two small *Medullary* risings, which are called, *Pyramidal Bodies*.

The fourth Ventricle lies under the *Cerebellum*. Its extremity points out like a Writing Pen, and accordingly is called *Calamus*. Near that place we spy an *Epiphysis* or *Appendage*, form'd of the substance of the *Cerebellum*, and called *Vermiformis* from its resemblance of a Worm.

Before *Descartes* appear'd in the World, there was no System thought upon, that could with any probability afford a mechanical Explication of the Animal actions: But after all, that Author's Hypothesis, tho' never so Ingenious, is so disagreeable to the Structure of the parts, that the World is oblig'd to drop it.

Galen fancy'd, that the vital Spirit is convey'd by the Arteries to the Brain, where it is converted into an Animal Spirit by the Air suck'd in by the Nostrils; that the particles of the Air are mixed with this Spirit in the four Ventricles; that the Spirit moves from thence to the third Ventricle, where 'tis more perfectly Elaborated; and that then the fourth receives it in order to convey it by the *Calamus* to the *Medulla Spinalis* and the Nerves. Some *Galenists* are of the

the opinion, that this Spirit is suck'd in from the Arteries and Nostrils during the *Diastole*; and that 'tis thrown into the Nerves in the *Systole*.

This Opinion, or rather Combination of Errors, has nothing to recommend it, but the great number of its followers. What can we imagine more contrary to the Constitution of our Body, than such an advance; That the Air drawn in by the Nostrils is carried up to the Ventricles of the Brain; and that this Spirit rolls thro' insensible Passages from these fore Ventricles to the third, the fourth, and the Nerves; and does not slip out at the Patent ducts of the *Infundibulum*? Besides, the Ventricles are almost always found full of Serum, which bears no resemblance of what *Galen* calls, the Animal Spirit.

The Hypothesis of *Descartes* is the more probable of the two; and therefore will better deserve a scrutiny. He supposes, 1. That the Ventricles are full of Spirits. 2. That the *Glandula Pinealis* floats as it were in the middle. 3. That all the Nerves are inserted either round the Ventricles, or immediately in the *Glandula Pinealis*. 4. He alledges, that the Spirits must be divided into so many small Columns, each of which points to a Pore of the *Glandula Pinealis*. 5. That the Nerves are stretch'd like the strings of a Lute; and being jogg'd at one end by the impression of an external Body, cannot but communicate their motion to the *Glandula*. 6. That the motion of the *Glandula*, making it to incline to one side, determines the Spirits to sally out into certain Muscles. 7. That the motion of the *Glandula* gives the Soul occasion to think, and the thought of the Soul moves the *Glandula*, and orders the Spirits to repair to such and such branches of Nerves and Muscles, sooner than into any other.

Tho' this Hypothesis at first view seems probable, and gives a pretty mechanical account of most of the Animal actions; yet 'tis built upon supposals, that are inconsistent with the order and disposition of the parts. For, 1. It cannot be maintained that the Spirits are lodg'd in the Ventricles. 2. The *Glandula Pinealis* is fixed, and cannot bend or incline to one side, as he supposes. 3. 'Tis manifest, that the Nerves are not inserted round the walls of the Ventricles, nor in the *Glandula*.

The followers of *Gassendus*, and particularly *Dr. Willis* believ'd, that the subtilest blood mounts up to the Brain, by reason that the Arteries are almost Perpendicular, especially in a Man, when he stands with his Head upright. According to their System, this blood throws off some of its impurities in the *Glandula Pituitaria*; and the rest, is, as it were, distill'd in the small Pipes of the Cortical substance, where 'tis received by the Strings or Fibres of the White substance, as by so many snouts of *Alimbecks*: From whence it runs into the *Corpus callosum*, and the *Medulla oblongata*, and from thence glides into the Nerves. They alledg, that the beginning of the *Medulla oblongata* is the seat of the *Sensorium commune*; that when the impression has strength sufficient to move the Spirits in the *Corpus callosum*, the Sense is follow'd by Imagination; and that, when these impressions reach to the Cortical part of the Brain, they produce Memory, by rolling in the windings of its Surface. In their Hypothesis, the Nerves are not at all shak'd, but it is the Spirits that are variously toss'd, and continue their motion by a sort of *Undulation*. They add, that the Brain separates the Spirits that are employed in Voluntary motions; and that the *Cerebellum* produces the Nerves, and Filtrates the Spi-
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rits, that minister to involuntary Motions. Over and above all these suppositions, they alledge that the Spirits are entangled in a volatile Oily humour.

To disprove this Opinion, 'tis observable that all their advances are without proof. What reason have they to say, that the Functions of the Soul are carried on in different apartments; Nay, if it were so, why should the *Sensorium commune* be plac'd in the *Corpora striata*, rather than in the other parts of the *Medulla*? Or why should the imagination be confin'd to the *Corpus callosum*, and the Memory to the windings? That Opinion will never be entertain'd by those, who consider that some Animals that have least Memory, or seem to have least, have most of these windings. And a superficial view of the nature of *Undulation*, will shew clearly that it can only take place in the surface of two liquors, of a different nature. But that is not sufficient to undeceive Physicians so misled by prejudice, as the retainers to that opinion are: And therefore I'll examin all their supposes apart.

In the beginning of this Second Part, I shew'd how the Blood ascends to the Brain; and if we call to mind what I there said, 'twill be easy to prove that the blood that ascends to the Brain, is not more subtil, than that which descends to the lower parts. 'Tis true, most of the new Philosophers have rashly advanced the contrary: But, the following reasons will undeceive them.

1. The blood drawn from the *Crural* Arteries and the *Carotides*, is all of a piece; and the one is not more subtil than the other.
2. The parts of the blood are too exactly mix'd, and their Stream is too Rapid to allow of a separation in the instant of the impulse they receive, that determines 'em to the ascending branches of the *Aorta*.

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As for their other supposes: I cannot see how the blood that ascends to the Brain should be purified in the *Glandula Pituitaria*. Indeed if this blood went thro' that Gland, it might separate some parts, and so the rest that ascends to the Brain might be purer: But the blood that passes thro' that Gland is so far from ascending to the Brain, that it returns by the Jugular veins to the Heart. To go on, the Spirits rolling in the *Corpora Striata* are grosser, and less refined than those in the rest of the *Medulla*, since their Pores are more open, witness their black Spots: So they cannot be taken for the Seat of the *Sensorium commune*; and neither that small portion of the White substance that unites them, nor their scissures, can amount to any proof on their side.

'Tis true, the smelling Nerves may communicate their Motion or Undulation to those Bodies; but I cannot conceive how the *Acustici*, or hearing Nerves can give them any impression, without imparting it first to all the *Medulla*; and in that case the whole *Medulla* will come in for the Organ, instead of one of its parts. 'Tis certain, that in Dropsies of the Head, where the range of the Spirits in the tracts of the Cortical substance is cramp'd, the Memory is not impair'd, which it must have been, pursuant to their System: Besides, the Undulation of the Spirits is impossible, unless you understand by that the Sallies of the same Spirits in the Brain, occasioned by the pressure of the external parts of the Nerves, which are always full of Spirits; just as when a Tube is full of Liquors, and a pressure happens at one end, they shoot to the other which is undisturb'd. Now this can never come to pass in the Nerves, for the Spirits that run incessantly from the Brain to the Parts, and according to their *Hypothesis* give being to the motion of the

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Muscles;

Muscles; these Spirits, I say, being often excluded from any other Passages, but the same very Nerves, which Minister to the Sensation of those parts, would oppose that motion from without inwards.

Some Moderns, not contented with all these Explanations, affirm that the Cortical part of the Brain is a Conglomerate Glandule; and the White substance is a collection of filaments or strings rising out of each little Gland: which by lying more closely together, form the Nerves, which, to speak properly, are only the excretory Pipes of those Glands. They tell you, that the unevenness of the surface of the Brain, serves only to enlarge the extent of the Cortical part, in order to enable it to strain out a greater quantity of Spirits: As for other things, they find no difference between the Brain and other Conglomerate Glandules; and when they are desir'd to apply their Principles to the Business of Sensation, they are obliged to have recourse to improbable Systems. For instance, some of the most famous Authors of that Party, have believed that the Soul is seated in the Membranes, because these are the most sensible parts of the Body; but were I not afraid of falling into Metaphysical Arguments, I could make it appear, that according to that Principle, most Objects would be multiplied before the Senses, and we would be at a loss to form any judgment of 'em, for want of a re-union.

Tho 'tis doubted if the Cortical substance is Glandulous, yet we cannot doubt, but that 'tis it alone that imbibes the parts of the blood, and that 'tis one of the strainers that separates some liquor from it. What the Authors of the last Party advance concerning the re-union of the Medullar part, is very just; but their Ideas are
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so flat, that they cannot reach the Explication of those Functions that depend simply upon the mechanism of the parts : So that upon the whole, we must look out for another System ; provided we can find one that is not inconsistent with the structure of the Body, and accounts for all the *Phænomena*, with few supposals.

Having rejected these Opinions : We shall suppose, as we did before, that the Cortical part of the Brain allows nothing to pass into the *Medullar*, but the subtilest parts of the blood, which then have neither the tincture nor consistency of the blood ; and the more there is of this Cortical part, the more will there be of that Spirituous liquor, pursuant to this Doctrine. Since the *Cerebellum* has a prodigious quantity of Cortical parts, it must supply the Nerves with a greater number of subtile parts, than the Brain does, and accordingly is employed to feed the continual motions. Hence we may readily conclude that the *Corpus callosum* does not at all differ from the *Medullar* substance, unless it be in the compactness of its Fibres. If we think but a little of this matter, we will easily be perswaded, that the Ventricles have no hand in the Animal functions, or the generation of the Spirits, unless it be to do the office of a *Balneum mariæ*, by the gentle heat of their moisture : But their principal service is, to receive the Water filtrated by the Glands of the *Plexus chorcides*, and some other Glands, which water they afterwards void. The fore Ventricles, and the fourth, empty themselves into the third ; and that into the *Infundibulum*, which reaches to the *Glandula Pituitaria*. This *Glandula* imbibes the moisture by little and little, and empty's it self into the veins or lymphalick Vessels.

Upon these supposals, we may easily unfold the use of the *Corpora striata*, the *Thalami nervo-*

rum Opticorum, and of all the parts of the *Medulla*.

I take every Rising, or Protuberance, to be a spreading and shedding of the strings of the Nerves; or rather to be the place where the Fibres of the *Medulla* begin to fall closer; in those places they are indifferent well stretch'd, and indeed the whole *Medulla oblongata* seems to be the seat of the *Sensus communis*, and that for several Reasons. 1. The Nerves give the impression to some part of the Brain, in order to raise the Perception: For if you tie, or cut 'em between the part and the Brain, the Modifications of Objects are no longer perceived. 2. All the Fibers of each Nerve are drawn together in every rising of the *Medulla oblongata*. 3. The Impression cannot be sunk any where else but in those parts.

From these Premises, 'tis manifest, that Sensation is not perform'd in the External parts, or the Organs. For, 1. The ligature or cutting of a Nerve, sinks the Sense of the Part. 2. If the Impression should terminate in the Organs, it would be impossible to explain mechanically, how the motions of our Body follow the shaking that Sensation occasions? 3. The Impression cannot dye in the Membranes; for they are extreamly stretch'd. 4. Upon the Amputation of a foot or a leg, the same pains are felt in the separated part, that were before the separation.

The *Corpora striata*, are composed of several lays of the White and Ashy substance, mix'd together, which shews that their Fibres should lie more loosely, and be more flexible. Accordingly the Motion of the smelling Nerves makes a strong impression upon 'em, but 'tis presently sunk. The *Medulla* of the *Talami* of the *Optick* Nerves being whiter and firmer, is not so movable, so that the





the impression continues longer there. Thus, a good Smell may indeed gratifie us more than an agreeable colour, but its Idea will not last so long: But after all, 'tis possible there may be some Fibres in the *Corpora striata* as much stretch'd as those of the *Thalami nervorum Opticorum*; since the simple smell of a Rose, will re-call the Idea of its colour: Of which, more at large else where.

The nerves of the Ear, do not terminate in particular Tumors; Their Strings or Fibers are confounded with those of the fifth and eighth pair, in the *Annular Protuberance*; insomuch that the impression they give cannot be very distinct, and all noise would at first seem to relish of Confusion, if these tracks were not made deeper by Art and Custom.

Tho' the Nerves of the Tongue are inserted in the same Prominence, yet its impressions are more distinct, by reason that the object of Taste touches the Organ immediately, and consequently acts with more force.

TABLE, XII. from WILLIS.

Fig. 1.

- aa. The two Lobes of the Brain.
- b. The Corpus Callosum.
- cc. The Fornix, with the two Pillars.
- dd. The Fore Cavities of the Brain:
- ee. The Corpora Striata.
- ff. The Thalami nervorum Opticorum.
- g. The Glandula Pinealis.
- bb. The Nates.
- ii. The Testes.
- K. The Medullar Prominences that reach from the Testes to the Cerebellum.
- ll. The Cerebellum.

- m.* A part of the Cerebellum, shaped like a writing Pen.
- nn.* The Medullar Prominences which joyn the Nates to the rest of the Medulla.
- o.* The end of the Medulla.

Fig. 2.

- aa.* The Corpus Callosum.
- b.* The Basis of the Fornix.
- c.* The Hole leading to the Infundibulum.
- dd.* The Thalami nervorum Opticorum.
- ee.* The Medullar Prominences, mark'd *nn.* in

Fig. 1.

- ff.* The Nates.
- gg.* The Testes.
- bb.* The Pathetick Nerves.
- i.* The joyning of the Prominences that rise from the Testes to the Cerebellum.
- mm.* The Protuberancies that make the Annular Eminence.
- nn.* The last Medullar Prominences.
- O.* The place of the fourth Ventricle.

CHAP. IV.

Of the Senses, and their different Operations.

IN order to know how external Bodies are perceived by our mind; we ought to be convinced that in the time of our perception, something prevails in the Body, that was not there before; and that 'tis that change that determines the mind to perceive, or form an Idea of such and such an Object. This supposes, that external Objects give a new Modification to our Machine,

chine, and by perceiving the Effects the Soul distinguishes the Cause that produced 'em, tho' perhaps the Effects have but little resemblance of their Cause; and if they did resemble it, that does not explain how the Soul comes to perceive it, since there can be no immediate connexion between it and the Body. If we were acquainted with the nature of the Soul, perhaps the difficulty would not be so great; but since we cannot resolve it, at least we may elude it, by saying that upon the union of our Soul and Body, God Almighty made certain Laws, Namely, that upon such and such Motions, the Soul should have such and such Thoughts; and upon such and such Thoughts, the Body should have such and such Motions.

In matters that cannot be trac'd by reason we are obliged to have recourse to a supernatural Power. 'Tis possible God made no particular Law for the union of the Body and Soul; but we are apt to imagine so, because we have not a perfect knowledge of either the one or the other. When we consider, that the Body is only capable of Extension, Divisibility, Motion, and Figure; and on the contrary, that the Soul has none of those properties: We must not Imagine that their union consists in an immediate application of the one to the other: for since a Spirit takes up no room, we cannot say that 'tis distant or at hand. The mutual union of Bodies consists in contiguity; and that of Souls in the conformity of their Sentiments. But, forasmuch, as the Soul has no surface to touch the Body with, and the Body has no Sentiments, their union seems to be impossible: And therefore we are forc'd to have recourse to another being, that unites 'em; being convinced that some changes in the Body move us to think, and our thoughts are follow'd by the motion of the Body. The union of the Soul and

Body, consists in the conformity of our thoughts to our corporeal actions : But, for the explanation of this conformity, we must have recourse to a Sovereign Power.

Whether the union of the Soul is founded upon a particular Law, or only a consequence of the general Laws formerly establish'd by God; 'tis still certain that the modification of the Organs continued to the Brain, is only an occasional cause of our Thoughts, that is, that on such an occasion God produces such thoughts in our Soul, in a manner unknown to us. I add, that it is necessary these modifications should terminate in the Brain : For, when they do not reach the Brain, the Soul seems to be unconcern'd ; which shews that she does not lodge in the Heart, nor in the Membranes, nor is she diffused all over the Body. In short, we want only a point to which the Soul is confin'd : For when the motion of the Nerves does not reach that point, we have no thoughts or perception of the cause that occasioned 'em : And, when that point is mov'd, tho' without any particular modification either in the Membranes, or the Organs, we sometimes attribute Sense to them, even when they are separated from the Body, as in the case of those who have had a Foot or a Hand cut off, and still complain of pain in the Fingers, or other parts of the separated Member.

But supposing that it is but one part of the Brain, the jogging of which will only occasion sensation : Still we must know what that part is, how it is moved, and what relation the Motions have to one another.

The most bigotted *Pyrrhonians* must needs be convinc'd by an infinity of Experiments, that the nervous parts are very sensible ; and that 'tis by their means that objects make us sensible of

of their friendly or unfriendly disposition, not only to the Soul, but to our whole Machine. This is manifest, when the Nerves of any part are cut, or disordered by a pressure, obstruction, or ligature; for then the Soul has no sensation retaining to the motion of that part.

If the Nerves did not convey the external impressions to a certain part of the Body, the Soul would never distinguish them, and would not interest it self at all in the matter, for it judges naturally that the motions that do not reach that part are not capable of incommoding the Body, in the preservation of which it is concern'd : For the same jogging or shaking that occasions thoughts in the Soul, does likewise occasion certain motions in the Body, that may be profitable or pernicious.

The manner in which the Nerves are shaken, cannot be fully understood without being acquainted with the necessary disposition of the Nerves and the Object, in order to sensation. The qualifications of the Object vary according to the Sense it is to operate upon. For instance, such objects as influence the Sight, must be exposed to the light, since without light there is no seeing. Those which influence the Ear, must have a great Spring, and be placed in Air : For, in an Air Pump they lose their sound. Those which affect the Smelling, ought to have subtil and volatile parts, with an indifferent strong agitation, in order to be able to insinuate themselves into the Nose in Respiration : For when one does not breath, he smells but very little. As for the qualifications of the Organs : The Nerves in general should be well bent, to promote the continuation of the Vibrations ; for the motion is not then so easily lost, as when they are soft and unbended : And tis upon that account, that
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the more stretch'd the Fibres of the Nerves are, their parts are the more sensible. Since these motions are the occasion of our Ideas, 'tis very probable that they have such a mutual relation, as our Thoughts have to one another. So that when one *Idea* leads us to the thoughts of another, the reason is, the relation of the motion that rais'd the first *Idea*, to that which rais'd the second: Or else that the first motion occasioned not only the first *Idea*, but likewise that motion that rais'd the second. Besides, it may happen that the same motion repeated several times, may occasion another *Idea* different from what it occasion'd at first, by vertue of a new turn and attention of the Mind. For instance, the influence of a black Body occasions in a vulgar Man the Idea of extension, cloathed with some real quality; but when that honest Man becomes a *Cartesian*, the same sight will excite in him the Idea of absorb'd Light, or of a particular modification of his Eyes; for, being then in the state of a Philosopher, his Soul endeavours by an abstracted way of reflection to throw off the prejudices of Sense. Let it be as it will, 'tis certain there are some motions that have a mutual conformity to one another; but it is very hard to determine wherein that similitude consists.

The mutual alliance of these motions from without, proceeds either from the cause that occasion'd 'em, or from the time in which they are caus'd, or from the manner in which they are brought about, or else from the Fibres in which they are display'd. To explain my meaning, I say, first, that when any Fruit is at once entitl'd to a good colour, a good smell, and an excellent taste, the Soul joins to the motion of the Sight, the *Ideas* that call up those of the taste

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and smell. Thus, when one sees that Fruit drawn in a Picture, the conformity established by the Soul between this and the other motions, makes it capable to occasion all these *Ideas*. The same may be said of the Smell, that recalls the sense of colour, taste, &c. So that when I say, that several Fibres of our Brain are in *Union*, my meaning is, that such and such a Fibre is so bent, that when 'tis jogged, 'twill not only occasion the *Idea* that it naturally excites, but likewise several others: Whether it be that the Soul has tied 'em to this motion, or that the Fibre in moving it self imparts a motion to the others, the agitation of which gives rise to these second thoughts.

The Memory depends upon this union: For instance, when I see a Flower, I call to mind its smell, by reason that this impulse upon the organ of Seeing is so conformable to that of Smelling, occasion'd by the same Flower, that one of these motions occasions both these thoughts; or else, that some Fibres of the *Thalami nervorum opticorum* being mov'd, communicate their motion to the Fibres of the *Corpora striata*, with which they are in *union*, and that this last motion calls up the *Idea* of the smell in the Soul.

But after all, this simple conformity will not answer all the circumstances necessary for remembering: For which reason I mention'd a second, occasion'd by the time that gives being to the motions, without any necessity of the similitude of their Causes: For, when I stick a Pin in my Sleeve to make me remember to fetch a walk; this sign, which of it self has no relation to the thing signifi'd, is nevertheless so certain, that it seldom deceives me. The question then is, how the motion occasion'd by the Pin makes me think
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of walking. As I take it, the Soul does so tye these *Ideas* to the motion, that the Pin does not only call up the *Idea* that God has united to it, but likewise another that the Soul join'd to it of its own accord ; or else, when the Walk and the Pin present themselves together, the Soul puts into *unison* the different Fibres that occasion the *Ideas* by their motion ; so that the agitation of the one moves the other.

There remains still a great difficulty in explaining Memory. 1. How does one remember the time in which he did some certain things ? 2. How 'tis that things seem to come into our Mind of themselves ?

To the first, I answer, That time being successive, is call'd to Mind, by enumerating the actions that are known to be done at different times : Or else, the thing to be remembred was accompanied with remarkable circumstances when it pass'd ; upon which account the memory of things transacted on a remarkable day is very fresh and strong.

As for the second Query, I believe that several things to which we have heedlessly join'd *Ideas*, will make us remember 'em, though they have no relation to one another. It may happen likewise, that some Fibres being twitch'd by Liquours in the same manner as they used to be by objects, will call up certain thoughts in the Soul : Upon which score, phrenetick Persons, whose Blood has a rapid motion, especially in the Brain, have disorderly and very numerous *Ideas*.

This conformity of Motions, is observ'd not only in organs of different Senses, but in those of the same Sense : And doubtless this *unison* prevails in the Fibres of the *Talami* of the *Optick* Nerves, when two objects that are alike have affected

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the Organ in the same manner : And this properly is the fourth branch of conformity, I mention'd but now. For instance; upon the sight of a *Lewis d'or*, I call to mind a bad one that I had taken before; because the Organ being jogg'd much after the same manner, occasions not only the *Idea* of the present object, but that of the former. This might have been accounted for several other ways, but the explication I have now given is the plainest.

From all these Premises we are now to conclude, that the *Medulla oblongata* is the seat of the *common Sense*; that *Memory* consists in a particular disposition of its Fibres; and that the Nerves employ'd in sensation, impart to the separate parts of the *Medulla oblongata* the motions that occasion such and such sentiments in the Soul.

C H A P. V.

*Of the Medulla Spinalis, or Pith of the Back;
and of Motion.*

THE *Medulla* of the *Brain* and *Cerebellum* runs out in length, and descends to the *Vertebrae*, where it is to be accounted a body of nervous Fibres, which running out of the Bones in which they are lodg'd, divide and distribute themselves all over the Body.

This *Medulla* is cover'd with three Membranes; for besides the *Dura* and *Pia Mater*, it has a thin tender Membrane, call'd *Arachnoides*, and lodg'd between the other two. The *Pia mater* divides this *Medulla* into two parts, namely, the right, and the left; and all along the track of the division, there's a sort of a *Sinus*. 'Tis remarkable

markable that the Vessels and Cortical part of this *medulla* lie in the middle, and that the white substance is outermost.

The *dura mater* covers the Nerves that come forth from this *medulla*, as well as those that come from the *Brain*.

I chose to premise the description of the *Medulla Spinalis*, before I enter upon the motion of the parts; because almost all the Nerves that are detach'd from the *Spina*, terminate in *Muscles*, which are the known Instruments of Motion.

I do not advance that the Nerves have a proper motion, and contract themselves, as Dr. *Willis* says; but that they contribute to Motion in an insensible way, since they do not move the parts but by the means of the Muscles: And the Nerves that surround some Arteries are apter to receive a motion from them, than to impart any. 'Tis certain, that a string or cord displays almost all its efforts where it hangs loosest; and by consequence the Nerves would display their greatest efforts of motion in the Brain: Besides, they are so soft that if they mov'd much they would easily break;

Though 'tis not at all likely that the Nerves move the parts of the Body immediately, yet when they are cut or ty'd, the part in which they terminate loses its motion. So that they contribute something, but 'tis hard to tell what it is.

Most Authors, whose Reason is not clouded by Prejudices, explain Motion thus. The Blood contains a subtil matter, which separates it self from the gross Principles that cramp'd it, and runs into the Pipes of which the white substance of the Brain is compos'd, and from thence pass'es into the Nerves; and that either continually, as
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in the Nerves arising from the *Cerebellum*, or by intervals, pursuant to the influence of external Bodies, or the direction of our Will, as in the Nerves that spring from the Brain, and the *Medulla*.

'Tis alledgd, that these Spirits run out of the Nerves into the Muscles, which they swell and shorten; so that their moveable part is drawn towards the immoveable. The choice that the Spirits seem to make of the different Nerves is regulated either by their Sense, or by the different impulses of external Bodies, or else by a particular Law that God has made in tacking these motions to certain desires of the Soul. They add, that sometimes the same external objects that occasion such and such Thoughts, push the Spirits into the Nerves that terminate in such and such Muscles, which usually move at the Pleasure of the Soul.

This *Hypothesis* of the Animal Spirits, affords such happy resolutions for all the *Phænomena*; that it has been always made use of by Authors without taking the pains to prove it: All their study was to imbellish it, and render it more useful. They knew very well that these Spirits being very subtil, might easily fly out, and upon that score invented a nervous juice to detain 'em. And for fear they should be over-exalted by staying too long in one part, they invented a circulation of Spirits; and that nothing might be wanting, allotted them a Fermentation in the Muscles. But all this is but building upon the Sand: These are meer supposes, that may be well spared in the explication of the *Phænomena*.

I doubt much the existence of such Animal Spirits as they suppose, and therefore shall run over all the actions that they pretend to explain
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by that *Hypothesis*, in order to try if another explanation will serve.

1. When the Nerves are cut, or stopt, by a Ligature, or Obstructions; the parts which they serve lose their sense and motion; upon which score, 'tis probable they convey into these parts some matter that brings the Action about.

2. The *Carotides* and *Vertebral* Arteries, carry a subtil sort of Blood to the Brain, and the Jugulars carry off the coarser sort. This speaks a necessity of the Engagement of the subtil parts in the Brain.

3. The Brain is all over Glandulous, and would be of no use, if it did not filtrate Spirits, to be distributed by the Nerves.

4. Without these Spirits we cannot explain the Animal Functions, such as Sleep, Waking, &c.

In answer to the first Argument, I said before, that sensation is owing to the jogging of the Nerves; and since that jogging motion cannot be carry'd on in the same manner when the Nerve is ty'd or cut, 'tis no wonder that the *Sense* is gone: As for the loss of the Motion, I answer, that the Ligature of an Artery has the same effect with the Ligature of a Nerve; so that the experiment will attribute motion as much to the matter contain'd in the Artery, as to that contain'd in the Nerves. This shall be pursued more at large when I come to give in my conjectures on this Head.

As for the second Argument: I reply, that at that rate we might conclude that the Animal Spirits are equally form'd in all parts of the Body as well as in the Brain, since the Blood of the Arteries is always more Spirituous than that of the Veins; and such a conclusion is very improbable.

To the third and fourth Allegation, I reply, that the uses of the Brain and Nerves may be trac'd, as I did above, without supposing such Animal Spirits; and by what follows it will appear, that the Animal Functions may be explain'd without 'em.

Besides, there are several Arguments for disproving the existence of Animal Spirits. 1. Were these Spirits so subtil as 'tis alledg'd, they would rather slip out at the Pores of the Nerves and Muscles than inflame 'em; especially, since a coarse matter may succeed, and fill up the space they thus quit. To make out the necessary subtilty of these pretended Spirits, let's but consider that they must needs be subtiler than the Air, to have passage in the Glandules of the Brain, the Fibres of the white substance, and the Nerves; and to fally out in a moment from the Brain to all the parts.

'Tis in vain to pretend that the *Nervous Juice* prevents their dissipation; for it would equally cramp their motion, and penetrating quality, by reason that it cannot prevent their dissipation otherwise than by mingling the coarse and subtil parts together; and at that rate they might as well have suppos'd that the Spirits are but a little more subtil. For, 1. This Nervous Juice having less motion than the Spirits, must of necessity sink their motion by mixing with them. 2. The Nerves would be dry'd up by the flowing of a Liquor more active and more insinuating than the Air, which after all is not
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apparent.

apparent. 3. When one puts a Ligature upon the Nerve, it would swell towards the upper part of the Ligature, which is known to be false.

But after all, these objections do not quite overthrow the *Hypothesis* of the Animal Spirits. They only prove, that they are not extream subtil Liquors, and that they have no great hand in dilating the Muscles: And indeed, I do not question but that the Brain filtrates a clear and subtil lymph, which the Nerves imbibe insensibly, and which serves to stiffen 'em, just as water stiffens an extended Rope.

This conjecture will still conclude the jogging of a Nerve to be the cause of *Sensation*. But then the nature of Motion is hard to be explain'd, for we see some Machines form the most admirable motions without any Animal Spirits. Indeed, if we consider the matter nicely, we must own that there is a necessity for some matter to swell, and shorten the Muscle: But then the Blood may perform that office as well as the Spirits. The pressure and straitning of the veins of the Muscle, ensuing upon the jogging of the Nerve, will suffice; for then the Blood being imprison'd in the Muscle, heaves it up; or instead of the pressure of the Veins, the straitning of some bundles of fleshy Fibres, through which the Blood is to pass, will confine that Liquor to the Muscle, and so swell it up.

In order to understand this matter, we must know, that the extremities of the Muscles are variously surrounded with Nerves. As in *Tab. XI. Fig. 8.* the Muscle *a b* having each extremity of the Fibres *f f*, border'd at *d* and *e* by the Fibres of the Nerve *c*. And the fleshy Fibres *f f f f f* are to be look'd upon, as so many Pipes for Communication from the Artery *o* of the extremity

trernity *b*, to the Vein *v*, of the extremity *a* ; or from the Artery *o* of the extremity *a* to the Vein *v* of the extremity *b*. This premis'd, 'tis plain that when the Nerve *c* is jogg'd, shortned, or unbended, whether by the command of our Soul, or by the impressiion of external objects ; the circular Fibres *d*, *e*, are at the same time contracted, upon which the Blood perpetually thrown in by the Arteries stagnates in the Muscle, by reason that 'tis hinder'd from entring the Vein ; by which means the Muscle swells, and its moveable part is drawn up towards the immoveable.

In each Sensation, the Nerves being more bent, straiten the fleshy Fibres they surround ; and by Consequence each Sensation must produce a motion ; for 'tis easie to conceive, that a small abbreviation may cause a considerable Inflammation and contraction in the Muscle : So that the shaking of the Nerves does at once occasion the sensations of our Soul, and determine the motions of our Body. And perhaps, 'tis for this reason, that the motion and sense of the parts is sunk, when their respective Nerves are cut.

This Hypothesis will furnish us with a reason ; why *Hemorrhagies* in a Muscle are oftentimes accompany'd with Convulsions. We must always suppose the Muscles filled with Blood, and ready to act, by contracting themselves, if they are not controul'd by Antagonists. Now, when any force imprisons a greater quantity of Blood in one Muscle than in another, or expells it, the part must move. And if this diminution or augmentation is not regulated by the Will, the motion is involuntary.

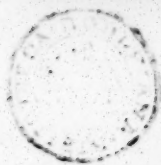
It may be objected, that at this rate the Ligation of a Vein would throw the part into Convulsions.

vulsions. I answer, that if the Vein were only concern'd with one Muscle, its stricture would contract the Muscle: But, since the Vein usually receives the blood both of Confederate and Antagonist Muscles, they'll mutually oppose its acting in that way. Besides, when a branch of a Vein is ty'd, there are oftentimes under the Ligature passages for Communication, by which the inferiour Branches empty themselves into other Trunks.

The twitching of a Nerve is a violent shaking and shedding of its Fibres, by which means the Air may get in, and ferment with the lymph contain'd in the Nerve, and by shortning it, straiten the fleshy Fibres, and arrest the Blood in the Muscle; and so produce an involuntary motion.

Thus, 'twere easie to explain all involuntary motions, just as I did those of the Heart and Intestines. But I reserve the farther explication of all these motions, till I come to speak of the parts in which they happen.

Upon the whole, we may conclude that the existence of such Animal Spirits as are talk'd of, is at least uncertain: And therefore we ought to call in question the common System.



CHAP. VI.

Of Sleeping and Watching.

IN Sleeping all the Senses are sunk; the perception of external objects ceases; and there's no outward action that can make us perceive that the Soul thinks: Unless you'll take some disorderly

orderly motions and words for the expression of thoughts. All the parts of the Body are in a languishing condition: In a word, *Sleep* is the Image of Death.

All these effects proceed from a new disposition of the Organs, and particularly of the Nerves, which are the principal Instruments of Sensation. I observ'd before that the bending of the Nerves was a necessary condition of sense; for, without that, the motion would not be communicated to the Brain, and consequently the Soul would be insensible of it. Now, in Sleep there's no Sensation; that is, the Impressions do not reach from the Organs to the Brain, by reason of the unbending of the Nerves.

I told you before, that the Nerves are bend- ed, and made more firm by a Liquor filtrated in the Brain, and convey'd from thence to the Nerves; just as a Rope soak'd in Water becomes stiffer. Now, to understand how the Nerves come to be unbended in Sleeping, we need only suppose that *that* Liquor does not repair to them in its wonted quantity. 'Tis plain, that when this Liquor is too gross, it is not filtra- ted, upon which account we are usually sleepy after eating; for then there are more coarse Particles in the Blood, which retard the separa- tion of the subtil Parts.

Indeed, this Liquor may be filtrated and pass'd to the Nerves in its wonted quantity, when the Nerves are unbended; for it may be too subtil to be confin'd, and that's another cause of Sleep. In watching, the parts of the Blood break, and split one another, and the Particles allotted for this Liquor become more subtil than usually; upon which it becomes incapable to stiffen the Nerves: And for that reason Sleep always fol- lows watchings, or laborious motions, in which

the Blood and all the Liquors of the Body are attenuated.

C H A P. VII,

Of the particular Senses : And first of Seeing.

Objects are perceiv'd two ways. One way is, when the object is immediately apply'd to the Organ, as in touching and tasting. Another way, is, when 'tis perceiv'd without immediate application, as in Seeing, Hearing, and Smelling.

By *Seeing*, we perceive things at a great distance, provided the object be luminous, and no opaque Body intervenes between it and the Eye. We perceive, for instance, the Stars, notwithstanding their immense distance. But in *Hearing*, the distance of objects must not be near so great.

The Ear has a great advantage beyond the Eye; for it perceives Sounds, notwithstanding the intervention of opaque Bodies between it and the object. As, in a close Room, one can see no light, though the Air be full of it; but the least Sound is perceiv'd.

In order to understand the reason of these two *Phænomena*, we must enquire into the nature of *Light* and *Sounds*. Light consists in the continued series of the balls of Air, which convey the impression from one to another, to a prodigious length. But when their Series is interrupted by any intervening Body, the impression is not communicated to the Organ. On the contrary, a sound, consisting in a reiterated motion, al-
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most like the tremblings of a rebounding Body, shakes the solid Body by turns, and that communicates the impulse of the Air contain'd in the Chamber.

The Eye is commonly guarded by *Eye-brows* and *Eye-lids*.

The *Eye-brows* are a set of Hairs, of which that part nighest the Nose is call'd the *Head*, and that nighest the Temples, the *Tail*. Their principal use is to break the force of the light that descends from above when one is bare-headed, and to stop the drops of Sweat from falling upon the Eyes.

There are two *Eye-lids* to each Eye in a Man. But in four-footed Beasts, Fowls, and Frogs, there's a third; which in quadrupeds serves only to keep the Eye clean and smooth; but in Fowls and Frogs 'tis a sort of Curtain, that they see through.

The Eye-lids are compos'd of Skin, Cartilages, fleshy Fibres, Glands, and Hair call'd *Cilia*. These Hairs are plac'd on the lower edge of a Cartilage. In Man, the upper Eye-lid is moveable, and the under one is immoveable. On the contrary, in Fowls the lower one moves, and the upper one does not. The upper Eye-lid is moved by two Muscles; one of which rises from the bottom of the *Orbita*, and is fasten'd to the edge of the Eye lid. When it shortens itself, it draws the Eye-lid upwards. 'Tis call'd *Superbus*. The opposite Muscle is a bunch of fleshy Fibres, common to the lower and upper Eye-lid. When it swells, it draws down the upper Eye-lid, the lower being unmoveable. In the lower and inner part of the Eye-lids, we meet with several little Glands, and some fleshy Fibres. The Glands filtrate what we call *the Wax of the Eyes*; and the fleshy Fibres serve to

squeeze out the glutinous Juice, that dries and turns into *Wax*.

After the Eye-lids, we come to enquire into the origin of *Tears*. That Liquor is filtrated in Glands that do not enter into the composition of Globe of the Eye. One of these Glands is call'd *Superior*. 'Tis seated near the little corner towards the Eye-lids, near to the first Suture common to the upper Jaw. 'Tis divided, as 'twere, into several lobes. Some Anatomists add a second, which stands at the great corner of the Eye near the entry of the passage that goes from the Eye to the Nostrils. These have Arteries from the *Carotides*, Nerves from the fifth and sixth pair, and Veins that terminate in the *Jugulars*.

We owe to *Steno* the knowledge we have of the use of the upper Glandule. He has observ'd that the *puncta lacrymalia*, which are holes situated at the entry of the passage to the Nose, receive the Liquor that was filtrated by the upper Gland, and convey it through that passage into the Nose.

A certain Anatomist that talks mightily of his discoveries, says, he has found out at last that there's no inferiour *Glandula lacrymalis* in Man: But, before his time, *Vesalius*, *Fallopins*, &c. told us that there was nothing there but a rising like a Bag; which is properly the entry of the passage that conveys the Tears to the cavity of the Nose.

'Tis observable, that the second Gland is only found in such Animals as have a third Eye-lid: And if there were any such in Man, his Eyes would often water.

The origin of Tears is the discovery of this Age. The Ancients being ignorant of their true cause, were oblig'd to feign one. Accordingly,
pursuant

purſuant to their notion of Vapours in the Body, they alledg'd that theſe Vapours aſcend to the Brain, where they condenſate, and diſtil upon the Eyes. There are ſome Authors, who advance, that 'tis much more probable, that ſo plentiful a Liquor as that of Tears, comes rather from a large Glandule, ſuch as the Brain, than from the ſmall thing now talk'd of. Theſe Reaſons had ſuch an Influence upon Mr. *Wharton*, that, ſince he could not avoid owning that the Tears ouſe from the *Glandula Lachrymalis*, he maintain'd that *that* Liquor is convey'd from the Brain to that Glandule by the Nerves: So that in his opinion, 'tis only a reſidue of the Nervous Juice.

But, if we believe that the Nerves have no ſenſible Cavity, nor any apparent Liquor, we muſt needs own that the Brain does not ſupply the Liquor that they ſtrain out. Now, the Brain being put out of the caſe, we muſt ſearch the ſtructure of the Parts, and look out for other ſources, that may be capable to furniſh ſo great a plenty of this Liquor.

One thing, which is very particular, is, that the Liquour which flows from the *Glandula Lachrymalis*, is not convey'd by Pipes to the place of its egreſs, *i. e.* The *Tear-bag*, where the *puncta lachrymalia* are plac'd: For it falls from the Excretory Veſſels of the upper *Glandula Lachrymalis* upon the whole globe of the Eye: And after 'tis gather'd into a Body in the lower Eye-lid, it run without a Conduit to the great Corner, and falls through the *foramina lachrymalia* into the paſſage of the Noſe.

Since theſe holes do not immediately joyn the excretory Veſſels of the *Glandule*, and ſince the Noſe paſſage is open at top, the lachrymal Bag having two holes; 'tis plain that when the Li-

quor

quor is too plentiful to enter all at a time into the Passage, a great part of it must go off in tears. So that now we must enquire, what it is that encreases the quantity of that Humour. This will easily be understood, if we observe that when the Jugular Vein of a living Animal is ty'd, it filters a prodigious quantity of *Saliva* and other Humours: For, since the Artery is always throwing in, and the Vein does not carry off its wonted portion of blood, the parts must be extremely distended; upon which, the Lymphatick and more penetrating parts of the blood, repair more plentifully to the ducts of the Glands. Now, the case is much the same, when Grief or any other Passion moves us to cry; for then it straitens the veins about the Eye, by which means the Lymph is hinder'd from repassing along with the rest of the blood, or at least its quantity that returns is much lessen'd; upon which the surplusage is filtrated by the Glandules, and evacuated in the form of Tears: For, when the whole cannot pass thro' the perforation of the bone of the Nose, the remainder falls upon the Eye. But at the same time, the passage of the Nose receives still a greater quantity than usually; and therefore when one cries, the Nose runs much. Add to all this, that the wry faces we make in crying, promote the egress of the liquor, by reason that in that case all the neighbouring Muscles press the Glandules and Veins of the Eye. And for the same reason, moist Persons, such as Women, can cry when they please.

The Ball of the Eye is compos'd of Vessels, Muscles, Membranes, and Humors.

As for their Vessels. The Arteries spring from the Internal and External *Carotides*; and joyn by an Anastomosis in the great corner of the Eye. The Veins open into the External Jugulars,

or

or into the *Sinus*'s of the *Dura mater*, at the bottom of the *Os sphenoides*. The Ancients allotted the Eyes two pair of Nerves. But Modern discoveries give us to know that they receive a second, third and fourth pair, all entire; and some branches of a fifth and sixth.

The second pair of those Nerves, which are call'd *Optick*, take their rise from the two eminencies, call'd *Thalami nervorum Opticorum*. After their egress from the *Medulla* of the Brain, they unite without interweaving their Fibres, and afterwards part, and run to the Ball of the Eye.

The third pair of Nerves, are call'd *Motores*. They rise from the bottom of the *Medulla oblongata*, behind the *Infundibulum*, and then advancing towards the second pair pass thro' a hole underneath that of the former pair; after which, each of 'em is split into four branches, which go to the Muscles of the Eye.

The fourth pair are call'd *Pathetick*. They take their rise from the *Medulla oblongata*, behind the *Nates* and *Testes*; and passing along with the former, are inserted into the great Oblique Muscle of each Eye.

The fifth gives only a branch, which is call'd *Ophthalmick*; and is distributed to the Muscles and Glandules of the Eyes.

The Sixth furnishes a branch to the *Indignatorius* Muscle of the Eyes.

In Man, the Eye is mov'd but by six Muscles, two straight, and two oblique. The four straight ones are fasten'd to the circumference of the hole, through which the *Optick* Nerve passes. The Muscle that is ty'd to the upper part of this hole, is fasten'd at the other end to the upper part of the *Cornea*. 'Tis call'd *Attollens* or *Superbus*, because its contraction draws the Eye upwards. Its opposite Muscle is call'd *Humilis*, because

because it moves the Eye downwards. 'Tis fasten'd at one end to the lower part of the hole, and at the other to the lower part of the *Cornea*. The third has one end ty'd to the lateral and inner part of the same hole, and the other to the *Cornea*, near the great Corner. When it contracts it self, it draws the Eyes towards the Nose, and is therefore call'd *Bibitorius*. The fourth is fasten'd at both ends directly opposite to the last, and by consequence is employ'd in a contrary Action, *viz.* Moving the Eye to the outer corner. 'Tis call'd *Indignatorius*.

There are two oblique Muscles. The first is call'd *Obliquus Minor*. One end of it is fasten'd to the upper part of the *Orbita*, near the inner corner. It rises to the upper part of the Eye, and passes through between the second and third straight Muscle; and at last terminates in the *Cornea* near the *Iris*. The second is call'd *Obliquus Major*: One end of it is ty'd to the upper part of the *Orbita*. From thence it runs to the upper part of the great Corner, where its Tendon passes through a small annular Cartilage, which may be call'd *Trochlea* or a Pulley, for it acts such a part on its behalf. Afterwards it terminates along with the *Obliquus Minor* in the *Cornea*, near the outer Corner.

Besides these Muscles, we find a seventh in Animals that carry their head parallel to the ground; which serves to fix the Eye in the bottom of the *Orbita*.

Authors are divided upon the action of these Muscles. 'Tis agreed by all that the straight Muscles perform direct Motion. But, 'tis doubted, whether they have any other use or not.

M. Robaut says that when they shorten themselves all together, they pull the eye out of the *Orbita*; and so make it larger but not so deep:

And

And that the Action of the oblique Muscles consists in pressing the Eye, and so enlarging its length and diminishing its breadth. Which, in his opinion, prevents the confusion of Objects, plac'd at different distances.

Within these few years, Mr. *de la Hire*, advanc'd, that the Eye could not change its figure upon the greater or lesser distance of Objects. But his Proofs amount to no more than that the change is not obvious to the Senses. He alledges, in opposition to the Ancients, that the oblique Muscles are not employ'd in the oblique Motions of the Eye; but only serve to bear it up, while the mix'd actions of the straight Muscles move it obliquely; just as the Arm is mov'd obliquely by the combination of strait Motions. But I cannot see how the oblique Muscles should suspend the Ball of the Eye; nor why their separate contractions might not assist the combinations of the strait ones. 'Tis very probable they serve to direct the two *Optick Axis's*, in looking upon the same Object when it moves round.

The humours of the Eye are lodg'd in a Ball compos'd of three Membranes, namely, the *Cornea*, the *Choroides*, and the *Retina*. The *Cornea*, or outer coat is properly an expansion of the tendons of the Muscles of the Eye. 'Tis hard and shining. The edges of its fore-part are white; which we call the *Tunica Conjunctiva*, or the *White of the Eye*. It forms the *Iris*, which is a little Circle, in some blue, in others green, &c. In the middle of which is a little black hole, call'd the *Apple of the Eye*. Its back part is call'd *Sclerotides*, and is not transparent like the former.

Under this we find the *Choroides*, which is black in Man, green in an Ox, &c. It lines the
Eye

Eye within. Its upper part, which is open, is call'd *Uvea*; and makes that hole of the Apple of the Eye, that appears in the middle of a Circle, and by reason of its Colours, is call'd *Iris*. The Apple is round in Men, but oval in other Animals. In a light place it contracts it self, but in a dark place it grows larger.

Next to the *Choroides*, is the third Tunicle, call'd *Retina*. 'Tis an expansion of the Fibres of the Optick Nerve, and encompasses the *vitreous humour* all round, excepting that part where the Chrystalline Humour is set into it.

The Cavity of these Membranes contains three Humours. The first is *aqueous*, or watry. Its quantity is indifferent great. It has the consistence of Water; and that side of it which faces the *Cornea*, appears in a convex form; whereas the other that looks to the Chyrtalline humour is *Concave*. The second is solid and transparent, and for that reason call'd *Chyrtalline*. One may easily separate from its surface a Tunicle that keeps up its state and consistency. Its figure is pretty much convex on both sides. Its Circumference is mark'd with several black Lines, which are call'd *Ligamenta Ciliaria*; and are lodg'd in order in so many small Cavities of the *Choroides*: And reciprocally, several black risings of the *Choroides* are indented in the Cavities between these Lines. Some take these to be so many Muscles for advancing or drawing back the *Chyrtalline Humour*: But 'tis much more reasonably suppos'd, that they are Vessels which furnish it with nourishment.

Behind the *Chyrtalline*, we find another Humour, call'd *Vitreous*; which is very transparent, and somewhat less solid than the *Chyrtalline*, upon whose side 'tis *Concave*; but on that side which faces the *Retina*, 'tis *Convex*. 'Tis enclos'd in
a par-

a particular Membrane, which is very fine. 'Tis five times larger than the *Chryſtalline*, and twice larger than the *Aqueous*. In *Tab. 14. Fig. 2.* one may perceive in the twinkling of an Eye, the different refractions of Light in all theſe Humours: For the light that enters the Eye, whether direct or reflexive, muſt be look'd upon as the ſame with that which paſſes from the Air into Glaſs or Water. Now, 'tis a certain Rule, that when the light paſſes from a leſs ſolid medium to one that is more ſolid, the Rays break and come nearer to a Perpendicular, if they enter ſloping. Indeed, if they fall perpendicular, they do not break, becauſe there's nothing to determine 'em to one ſide more than another. On the contrary, when oblique Rays paſs from a more ſolid medium to one that is leſs ſolid, they quit a ſtraight Line, and depart from a Perpendicular.

For a natural Reason of this, we muſt ſuppoſe that the Light moves in Chryſtal more eaſily than in Glaſs, in Glaſs more eaſily than in Water, and in Water more eaſily than in Air. Though this particular motion of the Light may ſeem contrary to all the motions of other Bodies, yet a reaſon may be given for it, by ſuppoſing that the Air contains a greater number of entangling parts than Water, and Water more than Glaſs, &c. Now experience proves, that, when a Body paſſes obliquely from a medium in which it mov'd with difficulty, to another in which it moves eaſily, it approaches to the Perpendicular.

'Tis to be obſerv'd, that all the Rays that riſe from a point of any Object, make a *Cone* of Light, the top of which is the point of the Object, and its baſe the ſurface of the Eye: And that a ſecond *Cone* of Light is form'd in
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the Eye, the base of which is the same surface, and its top a point in the bottom of the Eye, opposite to that by which it enter'd : For, all the Cones of Light cross one another in passing through the *Pupilla* and the *Chrystalline*. For the *Chrystalline Humour* is like a Glass Convex on both sides, fitted to the hole of the *Pupilla*. So that if the Object appears distinctly, it must be inverted. As in *Fig. 2.* the Rays of the two Cones are not united but at the point, in the bottom of the Eye *a*, opposite to the first : And 'tis evident that nothing must ensue but Confusion, when 'tis cross'd by the Lines *b* and *c* in *ddd*.

The same Principle proves that the Eye must change its Figure, pursuant to the distance of Objects. For, when the Object lies at a great distance, the rays of Light arising from it, must lie very close ; and consequently their re-union will fall to be very near the *Chrystalline*, and not on the *Retina* ; which is necessary to *Seeing*. On the contrary, if the Object lies very near the Eye, the rays being too much shed, cannot re-unite till they reach beyond the *Retina*.

For Proof, that the Rays arising from the same point of an Object, lie more scatter'd when the Object is near, than when 'tis far off ; do but cast your Eyes on *Fig. 9.* where the Rays *o c*, *o e*, being receiv'd by the Eye when 'tis at the point *a*, make a greater Angle in *b*, than the Rays *o d*, *o f*, receiv'd by the Eye at the point *b*. So that the Rays *o c*, *o e* in *Fig. 10.* will not re-unite till they arrive at the remote point *g* ; and the Rays *o d*, *o f*, in *Fig. 11.* will unite very soon in the point *b*.

Since the point of the Object from which the Cone rises, is not distinctly perceiv'd till the Rays of the same Cone are re-united : We may draw
this

this Consequence, that we cannot see distinctly when the Object is too near, because the re-union will fall beyond the *Retina*; nor yet when the Object is too remote, because in that case the re-union of the Rays will fall between the *Retina* and the *Chrystalline*. To remedy this inconveniency, when the Object draws too near, the oblique Muscles swell and lengthen the Eye, and then the re-union which otherwise would, have fall'n beyond the *Retina*, falls directly upon it. In like manner, when the Object lies at too great a distance, the straight Muscles act jointly, and bring the *Retina* nearer to the *Chrystalline*, by contracting themselves, and drawing the forepart of the Eye towards the bottom; which makes the re-union to fall upon the *Retina*.

This Principle will furnish us with reasons why old People do not see but at a distance, and large Eyes that jet out before, do not see well, but when the Object is very near 'em. For, in old People, the convexity of the *Chrystalline* is but very small, so that it could not re-unite the Rays upon the *Retina*, if they were not drawn near together before they enter the Eye. Whereas in large Eyes, the *Chrystalline* is very Convex, and by consequence re-unites the Rays just by it self; so that there's a necessity of scattering the Rays of the Cone before they enter the Eye; which is done by the nearer approach of the Object: Otherwise the re-union would not reach the *Retina*, but fall between the *Retina* and the *Chrystalline*.

From hence, 'tis plain, that Spectacles with Convex-Glasses, must be most proper for old Persons: For these Glasses gather the scatter'd Rays, and prepare 'em for a re-union upon the *Retina*. Whereas, on the contrary, large Eyes

that jet out, require Spectacles with Concave Glasses : For these disperse the Rays before they enter the Eye, and so atone for the fault of the Chrystalline, which re-unites 'em too soon. In like manner, Art supplies the defects of those who are short-sighted, as well as of those who cannot see but at a distance. For, when one is short-sighted, *i. e.* when the Chryſtalline gathers the Rays too soon, scattering Glasses will be serviceable. And on the other hand, when one cannot see but at a distance, *i. e.* when the Chrystalline is deficient in gathering the Rays, Glasses that promote the re-union will be of use.

We come now to satisfy the following questions. 1. Why objects inverted in the bottom of the Eye, appear as if they stood directly, and not reverse ways. 2. Why looking with two Eyes does not make the Sight double. 3. How 'tis that we perceive the distances, magnitude, and figure of Bodies. 4. Why we cannot see presently after passing from a very dark place to one that is very light, or from a place that is very light to one that is much darker. 5. Wherein does Colour consist.

As to the first question: 'Tis only prejudice that makes us believe, that when we see Objects strait before us, for instance, the top of a Steeple, it should therefore be painted just so in the *Retina* with the top standing upwards. We fancy that our Eyes are Windows through which the Soul views things; like a Man looking at a thing through a hole, who forms his Judgment of things by their relation to the *Horizon*. But if we would quit these prejudices, we would perceive that we do not judge of the Scituation of the Bodies, by the part which is affected in the Eye, but by the manner in which 'tis

'tis affected. Since this is common to all the Senses, particularly to touching; I shall illustrate it by an Example retaining to that Sense. Tho' the stick *ce* (in *Tab. XIV. Fig. 7.*) strikes in the same point that *ed* does, upon the Membrane *ab*. Yet we allot 'em different Scituations. And if the perpendicular stick strikes stronger than the oblique one, this last will cause no sensation, and the whole motion will be re-ferr'd to the Perpendicular. This is still plainer in the Eye. For, since the strokes of light strike the bottom of the Eye upon a level, they are always Perpendicular to the *Tangent* that may be drawn there: And since the Soul judges of the Object, by the manner in which the Organ is affected, it must judge the Object to be unturn'd, when 'tis so. For instance: When the Ray *be* in *Fig. 8.* strikes the *Retina* in the point *e*, the Soul is sensible that the Impression comes from *b*: For, since it struck it upon a level, the Soul judges according to *ce* the Perpendicular to the *Tangent io*: And not according to the oblique Line *ea*, which not falling perpendicularly made a less Impression and no sensation.

The second Question is not so easily answer'd: For, one would think, that since we have two Images of the same Object, we should see double. *M. Descartes* forms several Answers to it. He says that the motion or trembling of both the Nerves terminates in the same place, *viz.* The *Glandula Pinealis*; and therefore the sight is not double. But at that rate, we should never see double; whereas, when we turn our Eyes in a particular Eye, things appear double. In another place that Author compares the case of seeing simply with two Eyes, to a Blind Man that touches a Body with both his Hands, and yet judges it to be simple. O2 This

This comparison, as I take it, is not just: For when a blind man touches a Body with two hands, he cannot touch it but in different places; so that he has a sense of different parts, and the one Hand does not feel just what the other does.

I take the following Answer to be preferable. When we touch or see the same Body with two Organs, we judge it to be one; because we see it still in one place, and refer it to one place; for every point of the seen Object is directed upon one place by the Perpendicular Rays of each of the two Cones. This is what we call the *Direction of the Optick Axis's*. 'Tis a natural Consequence from this Explication, that certain distortions of the Eye will make the Object to appear double, because then we direct the same point of the Object to two different places.

The third question, relating to the distances of Objects, is equally hard; and has hitherto met with no other answer, but a few Conjectures. 1. 'Tis believ'd by some, that the change of the Figure of the Eye, upon the approach or remoteness of an Object, gives us to know their distances. But after all, I doubt, 'tis very difficult to adjust the Proportion between these Changes, and the judgments we make of distances. Nay, it seems more probable, that the Eye does not alter its Figure, till it's acquainted with the distances. 2. Some alledge, that *the Direction of the Optick Axis's* gives us to know the distances. Since we know the intervals of these Lines, and the angles they make with our Eyes, we cannot but know where these Lines terminate. Just as a Blind Man knows the length of two sticks without measuring 'em, by knowing the Angles they make with their own distance from one another, which he is suppos'd to know. The Allegation

legation is very ingenious. But after all, a one-Ey'd Man has not two *Optick Axis's* to measure the distance, and yet his Judgment of it is as good as another's. 3. We may know the distances, by the confusion or distinctness of the Figures, and by the force or weakness of the impression. Besides, supposing the *Retina* to be thick, when the Rays reach only its outer surface, the Soul perceives the Object to be at a great distance: And on the other hand, when the Rays advance deep into the *Retina*, 'twill conclude that the Object is very near. For the alteration of the figure of the Eye, does not hinder the re-union to fall nearer or farther off from the Chrystalline, according to the different distances; and by consequence the Soul may form a Judgment of the approach of Objects by their different advances into the substance of the *Retina*. *Lucretius* imagin'd that the distances were known, by the long tract of Air, that the surfaces of Bodies press against the *Pupilla*, before they reach it.

*Et quanto plus aeris antè agitur,
Et nostras oculus perterget longior aura;
Tam procul esse magis res queque remota videtur.*

But this Thought is only a consequence of the emission of little surfaces from the Object to the Eye: The impossibility of which the World is now convinc'd of.

'Tis not to be imagin'd, that the magnitude of the Figure at the bottom of the Eye, can direct us to judge of the magnitude of the Object. For an object remov'd but ten or twelve times further off than it was before, will make an Image in the Eye an hundred times less than before, and at the same time its magnitude does

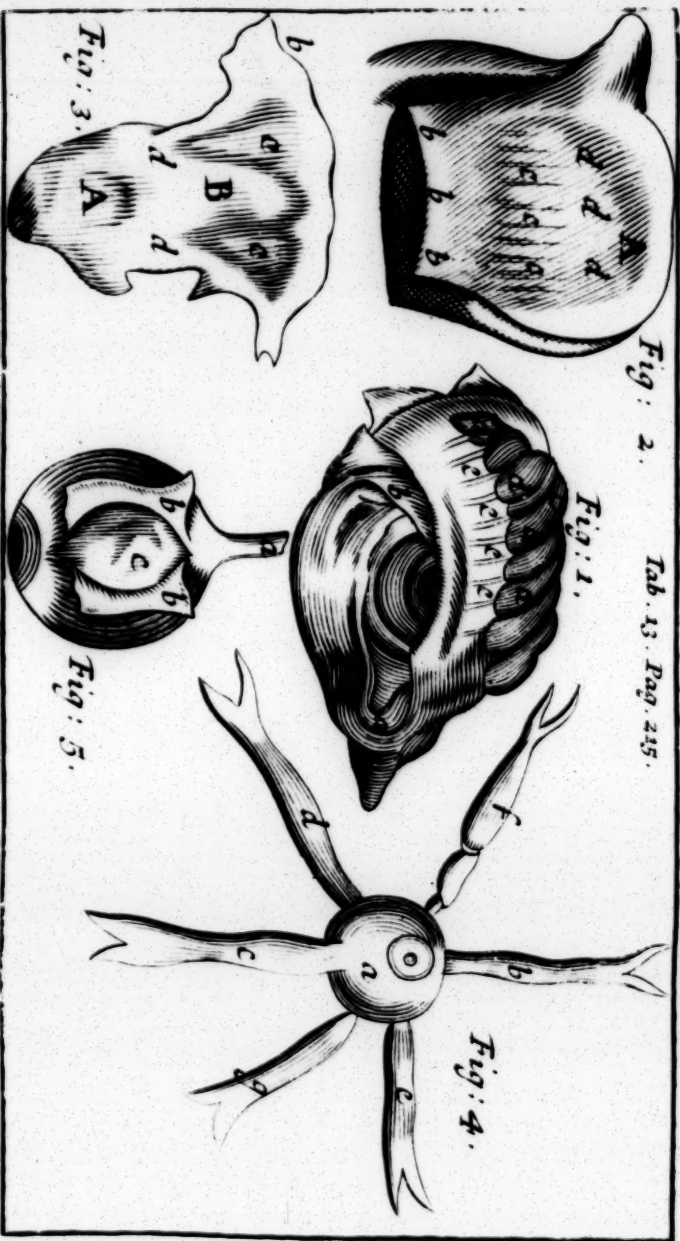
not sensibly differ from what it was before. As I take it, the knowledge of the magnitude of Objects, depends upon the estimate of the distance from our Eyes to the Extremities of the Object. For if we know the Interval between the extremities of the Object, we cannot but know the magnitude and Figure of that Body. And I know no reason why the Figure drawn in the bottom in the Eye, should not resemble the Figure of the Objects.

As to the fourth question: 'Tis certain, that the *Pupilla* which was much dilated in the dark place, cannot contract it self all on a sudden; and accordingly being oblig'd to let in a prodigious quantity of Light, when it comes suddenly to a light place, it causes a sense of Pain; because the Light falls upon such parts of the *Retina*, as were not wont to be affected by it; and their Fibres being very fine, the Sense is tender and painful. Now the sense of Pain being at that time stronger than the sense of Seeing, the one must stifle the other.

On the other hand; when one passes from a very light to a darker place, the *Retina* which was wont to be vigourously urg'd, loses its sensation at first, the impression being very weak in the obscure place.

But after all we may safely say, that the *Pupilla* is like a Muscle, and that a vigorous light by shaking its Nervous Fibres shortens them: Upon which they bind up the fleshy Fibres, which upon that occasion swell and shorten themselves, and by so doing, contract the hole of the *Pupilla*. But when the light does not act so briskly, the Nervous Fibres are unbended, the stricture and swelling of the fleshy Fibres ceases, and the *Pupilla* retrieves its natural state. Besides, for another way of explaining





plaining this *Phænomenon*, it may be answer'd, that the action of the *Pupilla* is voluntary. I mean thus. Though at every word, we do not give a particular Command for the Motion of the Tongue, upwards, downwards, &c. Yet all these motions of the Tongue depend upon our Will. In like manner, tho' we do not give particular Orders for enlarging the *Pupilla*, in the absence of light; 'tis sufficient if we have a general Will, to see well; for pursuant to that, the *Pupilla* opens in the dark, and shuts in the light, that being the true way to see and distinguish Objects. The same reason may serve to explain the different actions of Muscles, according to the distances of Objects.

We distinguish colours by the modifications that the Light receives from Bodies, whether by reflection or refraction. If it comes by reflection, it depends upon the surface of the Body; if by refraction, it depends upon its Figure and solidity.

T A B L E XIII.

FIG. 1. *From STENO; Representing the Eye of a Calf.*

- a. The great corner of the Eye.
- b. The little Corner.
- c. The upper Glandule.
- d d. The Lobes and their Interstices; from which spring the Lymphaticks, e e e,

FIG. 2.

- a. The Inner surface of the Eye-lid,
 - b. The upper Glandule.
- O +
- c c c. The

- ccc. The Lymphaticks.
- dd. Their Orifices.

FIG. 3.

- a. A Rising call'd the lower *Glandula Lachry-malis*.
- B. The Cartilage.
- bb. Its Edges.
- cc. A Membrane.
- dd. Two little holes at the sides of the Cartilage.

FIG. 4.

- a. The Globe of the Eye.
- b. The Muscle call'd *Superbus*.
- c. The *Humilis*.
- d. The *Bibitorius*.
- e. The *Indignatorius*.
- f. The great oblique Muscle passing thro' the *Trochlea*.
- g. The little oblique Muscle.

FIG. 5.

- a, The Optick Nerve.
- bb. The *Uvea* separated from the *Retina*.
- c. The *Retina*.

T A B L E XIV.

FIG. 1. Representing an Eye cut up.

- a. The *Pupilla*.
- b. The *Cornea*.
- c. The *Choroides*.
- d. The *Retina*.

e. The

Fig: 1. Tab. 14. Pag. 216.

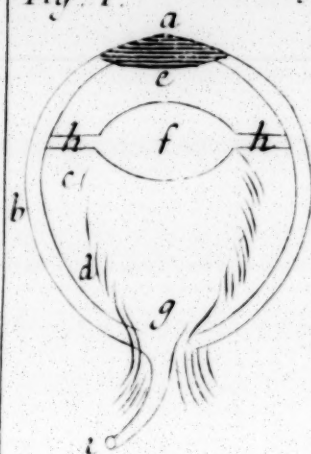


Fig: 2.

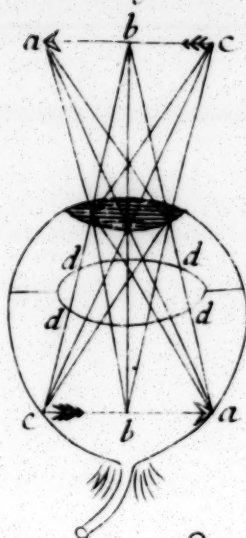


Fig: 9.



Fig: 11.



Fig: 10.

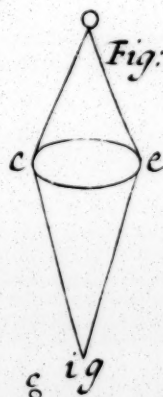


Fig: 8.

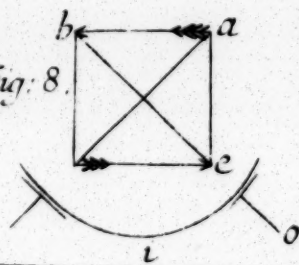
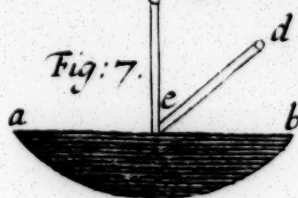


Fig: 7.



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- e. The *Aqueous*, or watery Humour.
- f. The *Chrystalline* Humour.
- g. The *Vitreous* Humour.
- h h. The *Ligamenta Ciliaria*.
- i The Optick-Nerve.

CHAP. VIII.

Of Hearing.

IN examining the Organs of Brutes, we find 'em like those of Men : And they seem to be affected in the same manner by the Presence of some Objects ; insomuch that 'tis very probable, that the moving of their Organs is join'd to perception. 'Tis true indeed, God Almighty may have disjoin'd these motions from Perception, and made 'em to be only the effects of a pure Machine. But since God can both do and undo, we are at a loss to determine how it is: Tho' at the same time we see several Animals that are so mov'd by the Presence of some Objects, that they seem to have some Senses more fine and delicate than Men.

*Nos aper auditu, Lynx visu, Simia gustu,
Vultur odoratu, praeclit Aranea tactu.*

The Bear has a finer Ear ; the *Linx* sees farther ; the Ape has a nicer taste ; the Vultur a better smelling ; and the Spider enjoys a more exquisite touch than Man.

I told you before, that, in order to understand the nature of Sensation, we must be acquainted

quainted with the particular Objects that influence 'em. For instance, *Seeing* cannot be explain'd without knowing the nature of *Light*; nor the perception of Sounds, without knowing the nature of *sonorous* Bodies. Pursuant to this method, I shall first describe the Organ of *Hearing*, and then the nature of its Objects. *Sound* is a collision of the parts of the Air, caus'd by a rebounding Body. This collision would make no lively impression upon the Organ, if it were not gather'd by the peculiar structure of the external Ear; much after the same manner as the Rays of Light, which would make no impression upon the *Retina*, if they were not collected in the *Chrystalline*.

The figure of the *Auricula* or external part of the Ear, is concave towards its Orifice: And those who are hard of Hearing, are oblig'd to augment the Concavity with artificial Instruments, or with their Hands. The substance of the *Auricula* is cartilaginous, and has a rebound; upon which account, it does not lose the impression of the Sound, so soon as it would if it were Flethy. 'Tis compos'd of a Skin and a Cartilage, which after making some folds, or windings, terminates in a Cavity, that, from its Figure, is call'd *Concha*. Some Anatomists say the external Ear has four Muscles. But it has only two. The first is a small row of fleshy Fibres ty'd to part of the *Perricranium*, which covers the Muscle *Crotaphites*, and joins to the second fold of the Cartilage. The second is fasten'd to the upper and fore part of the *Apophysis mastoïdes*, and terminates in the middle of the *Concha*. In Brutes these Muscles are scituated otherwise, for they make sensible motions. The Arteries of the *Auricula* spring from the external *Carotid*; the Veins open into the exter-

nal

nal *Jugular*; and the Nerves are deriv'd from the hard Process.

The Vibrations of the Air, gather'd in the *Concha*, pass to the Brain, through a passage, which at its entry is Cartilaginous, and afterwards bony. This Cartilage is divided, as 'twere, into five or six little parts. The passage is lin'd within with a Membrane clad with small hairs. Behind that Membrane, we find little Glandules of an oval Figure, each of which has an excretory Vessel that pierces the Membrane, and throws into the Passage a yellow glutinous Liquor, which we call *Ear-wax*.

The Cartilaginous part of the *Meatus* is join'd to the Bony, by several reciprocal risings, and by a Ligament deriv'd from the extremity of the *Concha*; which is inserted into the Temple Bone. Thus we see the External *meatus auditorius* is partly Cartilaginous, and partly Bony. The Bony part is of an Oval Figure, and towards the end winds a little. 'Tis exactly shut by the inner Extremity of a small, slender, dry, transparent, and bended Skin, which we call the *Tympanum* or *Drum*, and which separates the external Organ from the Internal. Though it is bent and stiff, yet it does not make one plain surface, for it is drawn inward by the handle of the little Bone call'd *the Hammer*.

Behind this Membrane, there's another Cavity, call'd *the Barrel of the Drum*. 'Tis three or four Lines deep, and five or six broad. It has two passages, one of which goes to the Mouth, and the other to the windings of the Process *Mastoides*. This Chest is lin'd on the inside with a Membrane, that's deck'd with Veins, Arteries, and Nerves.

The

The first passage, or *Aqueduct*, which goes from this Chest to the Palate, is bony in the beginning; but afterwards becomes partly Cartilaginous, and partly Membranous. It opens into the Mouth near the *Uvula*. Its orifice in the Mouth rises up a little in the form of a Half-Moon. By which contrivance, part of the Air that we swallow, is oblig'd to go into this passage, upon the same rules of Mechanism, that force the Blood of the *Aorta* to enter the *Axillaries*.

The second Passage lies above the *Chest*. 'Tis very wide and short, and penetrates to the windings of the Process *Mastoides*. Besides these two Channels, the *Chest* presents us with two holes, which we call *Windows*; and are seated in the *Os Petrosum*, opposite to the Membrane of the *Drum*. The upper *Window*, which is call'd *Oval*, is exactly shut by the foot of the *Stapes* Bone. The other, which is a little rounder, is shut by a fine thin Membrane, which is enchas'd in a small rift.

After the description of the *Chest*, we come to the four little Bones that it contains. The first is call'd *Malleus* or the *Hammer*. Its Head is plac'd in a *Sinus* at the upper part of the *Chest*. In the fore and hinder part of its Head, we find two little Processes, and a Cavity for its articulation with the *Incus*. The rest of this Bone is call'd the *Handle* which grows a little broader towards the end, and has two Processes, the largest of which is glued to the *Drum*; and the other faces the *Aqueduct*.

The *Hammer* has two Muscles. The first is plac'd along the external part of the Wall of the *Aqueduct*, from whence it goes into the *Barrel* from below upwards, being enclos'd in a cleft of the Bone, where the skin of the

Drum

drum is inchas'd: And at last terminates in a Tendon at the small process of the Hammer. The second is fasten'd to the extremity of the bony part of the *Aqueduct*. It rests in a *demi-canal*, or half Gutter, hew'd out of the *Os petrosum*; and advancing to the *fenestra ovalis*, passes under a small ledge cast up by the *Fenestra*; and at last runs thro' the Chest, and terminates in the hinder part of the *Malleus*.

The second Bone is call'd *Incus*, or the *Anvil*. We must distinguish its Body from its two Feet. The Body lies in the pit of the *Barrel*. It has two Cavities, and one prominence, for joining with the two Processes and Cavity of the *Malleus*, by a sort of a turning Joint. The shortest of its two Feet is ty'd by a Ligament in a Cavity near the passage that leads to the Process *Mastoides*. The longer one runs perpendicularly to the *Stapes*, to which it is ty'd.

The third Bone is call'd *Stapes*, or the *Stirrup*, alluding to its Figure. Its Basis flats the *oval fenestra*. In the inner part of this Bone, we find a little Gutter, in which a small Membrane is glud, as 'twere; upon which account 'tis said to resemble a Frame.

At the upper part of the *Stapes*, there's a little Bone, convex on that side, and concave where it joins with the Foot of the *Incus*. 'Tis call'd *Os orbiculare*: And is the least of all these Bones; none of which are cover'd with a *Periosteum*.

We observe a Muscle, that rises from the bottom of the *Chest*, and being enclos'd in a bony Gutter, terminates at the head of the *Stapes*.

In this part there are several very remarkable Nerves. The most noted of 'em all, is, the string of the *Drum*, which is a branch of the fifth

fifth pair, that passës behind that Membrane. The Ancients took it for a Tendon of the Muscles of the *Malleus*.

Thus I have dispatch'd the most considerable things in the Cavity. But the Impression of the Air does not sink there. It penetrates thro' the *Fenestra* or holes of the *Chest*, to the windings call'd the *Labyrinth*; which has three parts. The first is call'd *Vestibulum*, because it communicates with the other two. The second consists of three bony and Semi-circular Channels. The third is call'd *Cochlea*.

The *Vestibulum* is a Cavity of the *Os Petrosum*, lying behind the oval *Fenestra*, and lin'd with a Membrane clad with Vessels. It has nine holes. The first is the *Fenestra Ovalis*, by which it communicates with the Chest. Five of the rest serve for Communication with the Semi-circular windings. By the seventh it corresponds with the upper step of the *Cochlea*. The eighth and ninth give entrance to the Hearing Nerves.

The three Semi-circular Channels surround the vault of the *Vestibulum*. The first or upper Semi-circle opens into the *Vestibulum* by its extremity at the top; and going round the *Vestibulum*, opens in its middle part by a common hole into the end of the lower Semi-circular Channel; which beyond that continues a little more of the Semi-circle, and runs to the lower part of the *Vestibulum*, where these two Channels have a door of Communication. There is a middle Semi-circle between these two, which surrounds half of the middle part of the *Vestibulum*, and has two holes, one at each end.

To conclude the description of the *Labyrinth*, there remains only the *Cochlea*, to be describ'd. We are first to take notice of the Spindle,
round

round which we observe an oval sort of a Channel, that turns spiral ways. 'Tis divided in two by a *Lamina* or Plate fixed to it, and turn'd as it is; upon which account 'tis call'd *Lamina spiralis*. The Channel being divided into two by the Plate, makes as 'twere, two steps of a double Stair-case. The upper step communicates with the *Vestibulum*, and the lower with the barrel of the Drum, by the round *Fenestra*. 'Tis observable, that the *Spiral Plate* is fasten'd both to the Channel and to the Spindle, by a strong Membrane. At the place of their union, there are little holes that give passage to the strings of the *Nervi auditorii*. In the *Labyrinth* we meet with a branch of the internal *Carotides*, and one of the Internal *Jugulars*, which pass through the hole of the lower part of the *Os Petrosum*. They are distributed to the *Spiral Plate*, the Membrane that lines the Cavity of the demi-oval Channel, the lower step, the *Vestibulum*, and the Semi-circular Channels.

The *Nervus auditorius*, or Hearing Nerve takes its rise from the hinder and lateral part of the Annular Protuberance. This Nerve is compos'd of two Branches. The upper branch, by reason of its consistency, is call'd the *softer Process*; and the under one is call'd, upon the comparison, the *hard Process*. These two Processes pass through a hole in the middle of the *Os Petrosum*, above the hole where the Blood-Vessels pass. The soft Process is distributed into some branches; the most considerable of which goes to the Spindle of the *Coclea*, and seems to lose it self there; though at the same time it furnishes several little strings that pass through the little holes to the *Lamina Spiralis*. The other Branches run to the *Vestibulum*. Some of 'em enter at the doors of the Semi-circular Channels

Channels along with the Blood-Vessels. The *hard Process* goes to the external parts.

This premis'd; we come to the uses of this Structure. If we consider the sound with relation to the object from which it rises, we'll only perceive that there are some particular motions, which communicate themselves to the Air. For 'tis very probable, that *Sound* is the impulse of the subtile matter upon the gross parts of the Air; since it has two principal qualities. The first is, that 'tis not perceivable to us, but in an indifferent gross Air: The second is, that the motion proceeds from a Body that has a rebounding Spring, and perhaps the gross Air do's only contribute by its Elastick vertue.

It is a very natural consequence, from what has been said; that the cause of the rebound and the sound is much the same. For we know that the little Globes of Air may swell and unswell by virtue of reiterated impulses: And that modification of the Air is capable to make a sound. If we consider, that, when one Elastick body strikes upon another, their parts are mutually beat down; we must own that the subtile matter which was enclosed in them, passes into the pores of the neighbouring air, and squeezes the circumambient balls of air: And after that, that subtil matter re-entering with the same force into the Pores of the Body, from which it was expell'd, not only retrieves its first Bulk, but gives it a larger. And thus the Elastick Body continues in continual Vibrations, till the subtil matter obtains a free course, upon which it recovers its first Figure. But as the reiterated Pressure of the Elastick Bodies, expels the subtil matter by turns into the neighbouring Air; so the Air will be affected by the same reiterated Impulses.

Pursuant

Pursuant to this Hypothesis, we may easily explain, how Sounds are multiplied by the multiplicity of reflections. For, when the Air presses a solid Body, it always squeezes out the subtil matter, which runs into the circumambient Air, and increases the swelling and impulse of the aerial Balls. This Hypothesis may be further recommended, by remarking the impossibility of the Vibrations and Undulations of the Air. It will likewise unfold to us, why the Instruments for hearing are all made of Elastick matter, and why they are made so as to multiply the reflection of the Air : For all these qualities serve to augment the Sound : And the *Ew-nax* filter'd in the Glandules of the outer passage, is very serviceable in moderating the violence of that impression, especially at night.

When the Sound arrives at the Membrane of the Drum, it shakes it more or less, according as it is more or less bent. The stretching or bending of that Membrane, depends upon the Muscles that pull the handle of the *Mallens*. Thus, when we have a mind to hear a faint Sound, this Membrane stretches it self ; and then the weak impression of the Air will go further. When the Sound is very violent, this Membrane may unbend a little, and then the impetuosity of the impression is diminish'd.

The shaking of this Membrane is continued to the *Malleus*, the *Incus*, the *Stapes*, the *Vestibulum*, the Semicircular Passages, and to the upper step of the *Cochlea*. 'Tis very probable, that 'tis only the shaking of the different parts of the Semicircular passages that makes the distinction of Notes or Sounds. For instance, 'tis credible their broad part is only shak'd by a dull flat Sound, and their narrow part by a sharp shrill note : Just as in blowing a Trumpet, upon a sharp note the agita-

tion is in the narrow part of the Trumpet, and upon a flat note most of the agitation is in the broad part. So that, the Nerves of the narrow part of these Passages will be mov'd by a sharp shrill sound, and those of the broad part by a grave dull Sound ; by which means the Soul is able to distinguish them. Besides, an additional distinction may be fetch'd, from the different Vibrations that the Air makes in different Sounds.

Sometimes the Sound penetrates tho' the Aqueduct into the *Chest*, and *Labyrinth* : And for that reason, those who are hard of hearing, hear best when their Mouth is open.

The manner in which the Sound affects us, will discover what side it comes from : but we have but a very imperfect knowledge of the distance of the *Sonorous* Body ; for we can only judge of it by the strength or weakness of the Impression.

To conclude, 'tis very probable that the *Lamina Spiralis* and the *Cochlea*, serve only to continue the shaking to the *Acoustick* Nerves. 'Tis observ'd that the *Larinx* has a correspondence with the outer Ear ; which perhaps proceeds from this, that both of them receive Nerves from the *Hard process*.

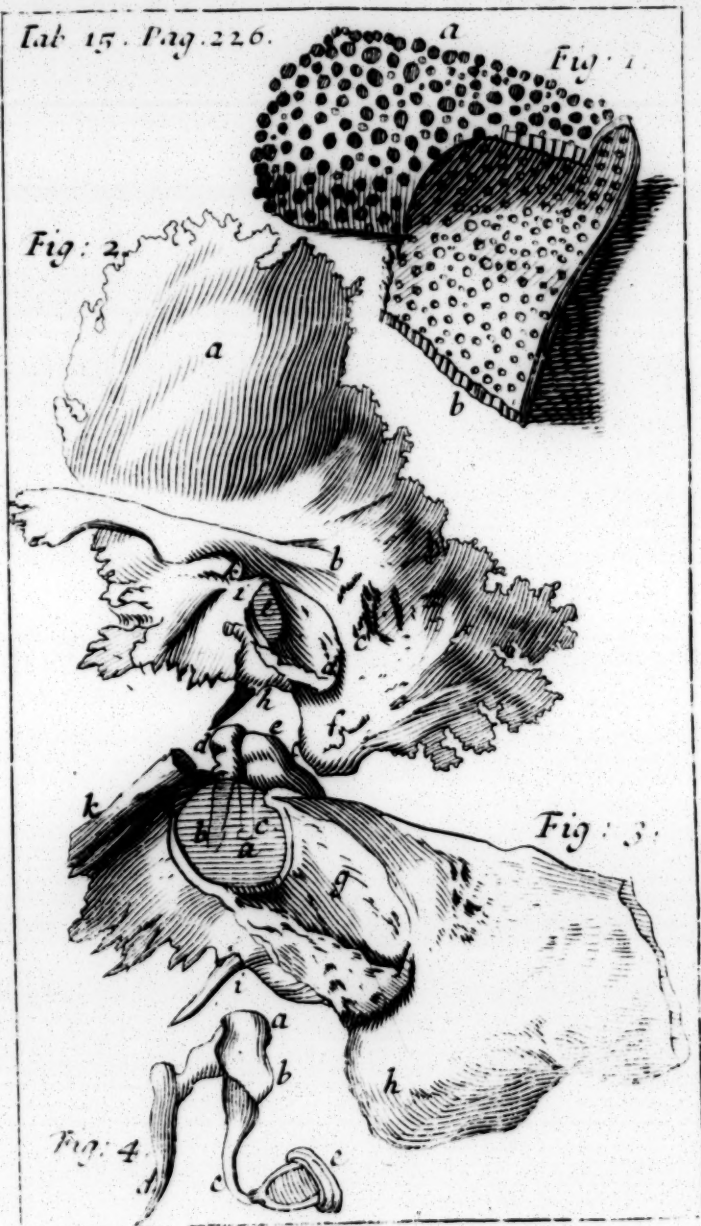
TABLE XV. Taken from Mr. Du. Vernay.

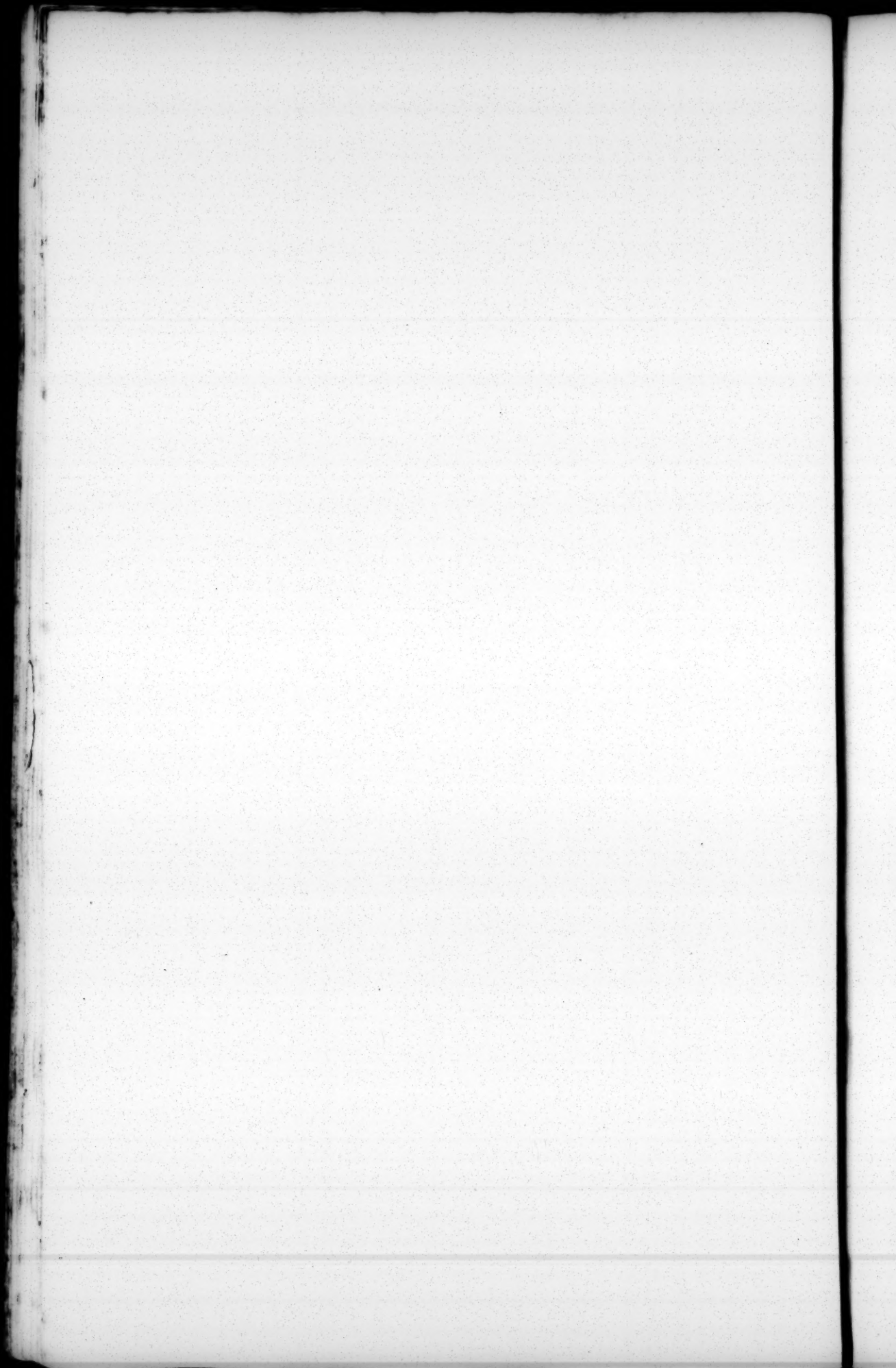
FIG. 1. Representing the Glandulous Membrane of the Meatus auditorius, about three times larger than it is naturally.

a. The Glandules of the External Passage of the Ear.

b. The Excretory Pipes of those Glands which open into the inner part of the Passage.

FIG. 2. Representing the Temple Bone lesser than 'tis naturally. *a. The*





- a. The Scaly part of the Temple Bone.
- b. The Process that helps to form the *Ossifugale*.
- c. The Cavity to which the Ligament of the Ear is fastn'd
- d. The Entry of the Bony Passage.
- e. The Membrane of the Drum.
- f. The Process *Mastoides*.
- h. The *Stylodes*.
- i. A winding Cavity between the Bony Passage and the Scaly part which gives Passage to the External Muscle of the *Malleus*.
- K. The Cavity that receives the *Condylus* or Head of the lower Jaw.

FIG. 3. Representing the Temple Bone, after the cutting off of the *Pars squamosa*.

- a. The Membrane of the Drum.
- b. The long Branch of the *Malleus*.
- c. The long Foot of the Anvil, appearing thro' the Drum.
- d. The Head of the *Malleus*.
- e. The Massy part of the *Incus*.
- f. Its short Branch.
- g. The Bony Channel half wasted.
- h. The Apophysis *Mastoides*.
- i. The *Stylodes*.
- K. The External Muscle of the *Malleus*.

FIG. 4. Representing the little Bones near the ear as great as they are naturally.

- a. The Massy part of the Anvil.
- b. Its short Foot.
- c. Its long Foot.
- d. The Handle of the *Malleus* or Hammer.
- e. The *Stapes* or Stirrup.

T A B L E XVI.

FIG. 1. Representing the Temple Bone without its Scaly part, in order to discover the Surface of the Os petrosum.

- a.* The Bony Passage spoil'd.
- b.* The Prominence of the Os Petrosum that covers the *Lamina spiralis*.
- c.* The Oval Window.
- d.* The round Window.
- e.* The Bony Channel, containing the Muscle of the Stirrup.
- f.* The Channel that encloses the hard part of the hearing Nerve.
- g.* One half of the Bony Passage, running from the Ear to the Pallate of the Mouth.

FIG. 2. The Temple Bone a little larger than the natural prepar'd ones are.

- a.* The Arch of the *Vestibulum*.
- b.* The Oval Window.
- c.* The round Window.
- d.* The Spiral Plate strip'd of the Spiral Gutter.
- 1.* The first Semicircular Channel.
- 2.* The middling Channel.
- 3.* The lower Channel.

FIG. 3. The distribution of the Artery to the three Semicircular Channels laid open.

- a.* Its Entry into the *Vestibulum*.
- b.* Its Passage thro' the common Gate.
- c.* The Branch that goes to the upper Channel.

FIG. 4. The Vestibulum and the Channels, lifted up, to shew their Orifices.

A. The

Fig: 1.



Fig: 2.

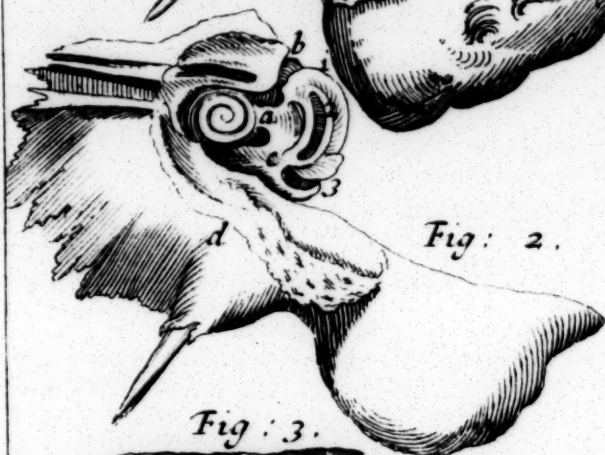


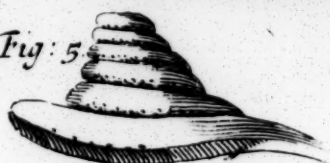
Fig: 3.



Fig: 4.



Fig: 5.





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- A. The lower part of the *Vestibulum*.
- B. The upper Channel.
- c. The lower Channel.
- d. The middle Channel.
- 1. The Gate of the upper Channel
- 2. The first Gate of the middle Channel.
- 3. The Gate of the lower Channel.
- 4. The other part of the middle Channel.
- 5. The Common Gate to the upper and lower Channel.
- 6 and 7. Two Orifices that give Passage to the branches of the hard process.

FIG. 5. Represents the Spindle, larger than 'tis naturally: in which we may observe the track of the Spiral plate, and some holes for giving Passage to the Twigs of the Nerves.

CHAP. IX.

Of Smelling.

TIS not easily determin'd, whether the sense of Smells in our Soul is occasion'd by the real *Effluvium's* of *Odorous* Bodies, or by the Air modified by these Bodies. 'Tis true, all Sense is immediately occasion'd by the shaking of the Nerves. But this shaking must be caus'd either by real *Effluvium's*, or by a motion impress'd by the Object upon the Air, or some other subtile matter. 'Tis not to be question'd, but that, in Tasting and Touching for instance, when the Object is not immediately apply'd to the Organ, there is a real detachment of Particles. Thus,

the Fire occasions a sense of heat, by the Particles it sends forth: And the Pounding of *Alces* in a Chamber occasions a bitter taste, by the subtil Effluvium's convey'd to the Tongue by the Air. On the other hand, in seeing and hearing, we cannot say that the *Sonorous* and *Colour'd* Bodies, send forth any Particles to occasion the Sense of Colour or Sound. But we are perswaded that these Objects only change the modification of Light or Air.

But the case of Smelling, is a point of more difficulty. For on one side, all Philosophers, even those who have rejected the real Effluvium's in the case of Colours or Sounds, affirm that Smells depend upon the real Efflux of *Corpusculum's*. To confirm their opinion, they alledge, that when a Body is of a volatil Nature and apt to dissipate, it has most smell; and from thence conclude that the exhalation of the Particles is the cause of that Sensation. They plead further; that when an *Odorous* Substance is heated, stir'd, or burnt, it has a stronger Smell, because its parts get away more readily.

But if it is true, as doubtless 'tis, that ther's no necessity of *Effluvium's* to make Colours; I do not believe there's any occasion for them upon the score of Smelling. For, when a subtil Air strikes against any perfume, it receives an impression from it; and by spurting up into the Nostrils, shakes the smelling Nerves in a particular manner. And this shaking is at least one of the occasional causes of smelling. When this Body is very Volatile, it has more motion, and consequently makes a greater impression upon the Air. From which we may conclude, that the heating, or burning, or stirring the parts of the Odorous Body, inflames the agitation of the Nerves: For, the violent moving of the Circumambient Air, must needs make the Smell stronger. At last, the Body loses the smell;
when

when the subtile Air by passing and repassing the Pores of the Odorous Body, breaks its Particles, and renders them incapable to modifie the Air as they did before. This *Hypothesis* affords us an easie reason, why some Essences will cast so great a Smell, and at the same time lose nothing of their Mass or Weight. I doubt much if any other opinion would admit of so easie an explication.

From these Premises, we may conclude, that an *Odorous* Body must have two sorts of parts; some subtile and rapidly mov'd; and some hook'd and entangling. The last detain the Air some time; which procures its Modification, and gives the other an opportunity of imparting to it all the necessary swiftness. In fine, these subtile parts would quickly slip out, if they were not fetter'd by the hooked parts; and 'tis upon this account, that, in Distilling a thing that smells, we draw off a great deal of Sulphur, and a great deal of Spirits. The Common Hypothesis requires only Spirituous parts for producing a Smell. And if the followers of it admit of Sulphurous parts, 'tis only owing to experience which obliges them to it; for all the World owns that entangling parts are not qualified for dissipation. The Hypothesis I now advance seems to be very plain, and agreeable to the operations of Nature. Not that I deny, that the Air cannot peel off some parts of the *Odorous* Body; 'tis possible that the Effluvium's of the parts, and the modifications of the Air, are the joynt occasional causes of smelling.

Having spoke of *Odorous* Bodies, we come now to treat of the Organ they work upon; viz. the Nose. 'Tis divided into External and Internal parts. Most of its Bones belong to the upper Jaw. Now the upper Jaw is compos'd of eleven

Bones, five on each side, and one in the middle. The first is that which together with the process of the Temple Bone, makes the *Os jugale*, the most prominent Bone in the Face. The second is call'd *Unguis*. 'Tis a little slender Bone, seated in the inner corner of the Eye, at the entry of the *Lachrymal passage*. The third is flat and smooth, and joyns with the opposite Bone on the other side in making the Bony part of the Nose. The fourth is the greatest of all the Bones of the Face. It makes the greatest part of the Arch of the Pallate, and receives part of the Teeth in its bony Sockets, which are call'd *Alveoli*. It has a hole thro' which a Branch of the Fifth pair passeth, and goes to the Eye-Teeth or *incisivi* and the face; as also some Blood Vessels. The fifth is the Bone of the Pallate, which has two holes, by which the Nose communicates with the Mouth. This Communication promotes Respiration, especially when the Mouth is shut. The Bone in the middle, which is call'd *Vomer*, resembles a ploughshare, and divides the Nose in two.

This rough description of the Bones of the upper Jaw, makes way for a distincter account of the Bones of the Organ for smelling.

The *Ethmoides* Bone is a bony Plate, perforated by several little holes. Towards the inner part of the *Cranium*, it has a rising call'd *Crista Galli*, and another within the Nostrils; about which we observe the *Ossa spongiola* or *Spongy Bones*, which are full of Cells like a Sponge; and rough on that side which looks to the Nose, but smooth where they face the *Orbita* of the Eye; upon which account they are call'd *Ossa plana*. Besides these Bones, we discover some bony Plates, which run parrallel to one another, along the side of the Nose, and are cover'd with the inner Membrane of the Nose, which is deck'd with Vessels, Ar-

teries, and Nerves. These serve to enlarge the Organ, and to render it capable to detain the Particles of Air, and receive their impression.

We must not overlook the *Sinus's* or Cavities, the *Membrana Pituitaria*, the Arteries, the Veins, and the *Mammillary* Processes.

The bony Cavities that empty themselves into the Cavity of the Nose, are plac'd in the *Os Frontis*, in the bottom of the upper Jaw, and in the *Os Sphenoides*. They contain the Membrane that we call *Pituitaria*, which is full of little Glandules, that filter the matter which we blow from the Nostrils. 'Tis true, the *Sinus's* of the Jaw and the *Sphenoides* bone, throw out but very little, when the Head stands perpendicular to the *Horizon*. But in a stooping Posture, their Inclination makes 'em evacuate the matter strain'd out by the little Glands. The *Foramen Lacrymale* furnishes a Liquor that serves to dilute this glewy Substance.

The Arteries spring from the *Carotides*, both external and internal. The Veins open into the *Jugulars*. The Principal Nerves, are, the *Processus Mammillares*, which proceed from the *Corpora striata*. Their Fibres are accompany'd with the *Dura Mater*; and having pass'd thro' the holes of the *Ethmoides* Bone, terminate in the inner Membrane of the Nose. Several Moderns alledge, that the *Processus Mammillares* convey some matter from the Ventricles of the Brain to the Nostrils: Going upon the notion of their being hollow. Dr. *Willis* has an Observation that backs this Conjecture. He tells us, that a Girl who was often troubled with the Head-ach, and voided a yellow Liquor at the Nostrils every day; was at last seiz'd with Convulsions, and dy'd Apoplectick: And when her
Brain

Brain was dissected, they found the Ventricles full of such a Liquor as she us'd to void at the Nose. But after all, Anatomy knows no passage from the *Ventricles* to the *Processus*; nor yet any way by which the Processes should distil this Humour into the Nostrils.

Having premis'd the description of this Structure; we may easily conceive, that the particles of the Air, having receiv'd an Impression from *odorous* Bodies, will shake the Nerves: And that this shaking motion being continued to the Brain, will engage the Soul's attention to the motion in the Nose. This is what we properly call *Smell*; and according as this impulse is stronger or fainter, the Smell will be either agreeable or annoying, strong or weak, &c. Pursuant to the Laws that God has establish'd upon the union of the Soul and Body.

C H A P. X.

Of Touching and Tasting.

HAVING treated of the Sensationss in which the Organ is distant from the Object: We come now to examine those in which the Object acts immediately upon the Organ, namely, *Touching* and *Tasting*. One might alledge, that these two Senses might be excited by a distant Object, since Fire heats at a distance, and the beating of *Aloes* occasions a bitter taste in the Mouth. But it may be justly repli'd, that this is brought about by the Effluvioms of the Objects, and that the Particles are applyed to the surface of the Organ. It may be objected still, that since the Sense of Smelling does not absolutely

folutely require the emission of Particles, touching and tasting may likewise do without it. But methinks that difficulty is easily resolv'd, since the dissipation of Particles in the Fire is very sensible, and the subtil Powder of the *Aloes* is visible in the Air.

The Taste that ensues upon the application of an Object to the Tongue, is only owing to the Impression of its Particles. The same may be said of *Touching*. But as for Seeing, Hearing, and Smelling, they require intervening Bodies to make the Impression bear.

Tasting is a finer way of *Touching*. For the Tongue can perceive any thing that the Skin can; but the Skin cannot perceive all that the Tongue teaches us to distinguish. But after all, the structure of the one is much like that of the other; insomuch that some have said, that these two Senses differ only gradually.

To know the structure of the Skin: We must consider, 1. That 'tis compos'd of a Plan of Tendonous and Nervous Fibres. 2. That several small strings of Nerves rise above this Membrane, and form little Pyramids, which are call'd *Papillæ Nervosæ*. 3. These little Eminencies adhere to the Cavities of another Membrane, which being perforated, gives passage to these little tufts, and is call'd the Reticular Membrane. Lastly, The Extremity of these *Papillæ* is cover'd with a *Cuticula* or upper Skin, that is very much bent; under which we find an oily Humour that keeps the *Papillæ* wonderfully supple; and according to its different Tinctures, varies the colour of the *Cuticula*. For, when we wash the *Cuticula* of a Negro, we find it as transparent as our own. In the surface of the Skin, we observe several Lines somewhat deep, which by mutual inter-

sections

sections make irregular Squares: And in these Intersections we descry with a Microscope a Pore and a Hair.

The Skin has Veins, Arteries, Nerves, and Lymphatick Vessels; and 'tis probable the *Cuticula* has some, for *Swammerdam* says, he Syring'd the Blood-Vessels in the *Cuticula* of a *Fetus*. 'Tis true this Experiment cannot be try'd upon an adult Body; for the cold Air by gradual Contractions, renders 'em too straight.

Under the Skin, there are Glands of an oval Figure; each of which produces an excretory Pipe that pierces the Skin, and terminates in its surface. The filtration of Sweat, and the transpiration of the Body, depend upon these Glands. This insensible transpiration, which is made not only by the Glands, but likewise by the Pores of the Skin, is so plentiful, that, according to *Sanctorius's* computation, it evacuates more in one day, than all the other Passages do in fifteen; that is to say, that the insensible Passages evacuate fifteen times more than the sensible Passages. I do not know whether his Calculation is just or not: But this I'm sure of, that the suppression of insensible transpiration occasions fifteen times more Diseases, than the suppression of all the other Evacuati-
ons in the Body.

Sometimes Sweat has a tincture of Venom. For, Sweating gives ease in the Gout, and these Pains cannot but proceed from very sharp Salts. It cures the Plague; and the suppression of the insensible Transpiration occasions putrid and malignant Fevers. Now these effects would never ensue, if Sweat did not contain some corrosive parts.

Pursuant to the foregoing account of the structure of the Skin: we may easily conceive,
that

that, when the surface of any Body is apply'd to it, it excites a particular motion, especially in the little *Papillæ*. This motion is continued to the Nerves, and the Brain; by which means the Soul receives advice of what passes in that Organ: And has a sense of something that's hard or soft, hot or cold; according to the agitation of the *Papilla*, and after them the Nerves.

It may be ask'd, what these *Papillæ* serve for; and why the Nerves are not immediately affected?

I answer; that external Bodies never operate immediately upon the Nerves. There's always some *medium* or other. In the Sense of Touching, a Medium is necessary; not to gather or augment the impressions, as in Seeing and Hearing; but to check 'em and break their shock, lest the Object by its immediate touch should create Pain. 'Tis easily made out, that these little Eminencies are the principal Organs of Touching, if we consider that the parts of the Skin which have most of 'em, are the most sensible; and that such parts as have lost the Skin, together with these Eminences, have no sense of Tickling or Touching, but only of Pain.

To know how we distinguish the hardness and softness of Bodies, we must first enquire into the nature of hardness and softness. I take a *hard* Body to be a Compound, whose parts are in repose, and not easily put in motion, or separated by touching. By a *soft* Body, I understand a substance of moveable parts which scarce resist the touch. Now, a hard Body will discover its hardness to us, by pressing the little Nervous Nipples; whereas a soft Body having little or no action for want of consistency,

fistency, will be so far from pressing them, that its parts will fly aside to give way to 'em. So that the motions of the Nerves which occasion such different thoughts, as what we call *hardness* and *softness*, must needs be very different.

Heat is a Sense occasion'd by the shaking of the Nerves of the surface of the Skin; which shaking proceeds from a motion of Particles proportion'd to the thickness of the Fibres of the Skin. On the other hand, *Cold* is occasion'd by disproportionate Particles.

To this description of the Skin, 'twill not be improper to subjoin a short view of *Hairs*. When we examine a Hair with a Microscope, we find it transparent and hollow. It has knots or joints like a Reed; and its possible its nourishment comes by these. Its Colour is diversifi'd by the various Tinctures of the Liquors that circulate in it. Before it comes out of the Skin, 'tis gather'd, as 'twere, into a little ball, and afterwards winds off it by little and little.

In old Persons, the Hair becomes white; by reason that when there comes but little moisture, the Fibres are more compact, and consequently capable to repulse all the Light that falls upon them. And 'tis by reason of the interruption of this Juice, that the Hair grows white in such places of the Head as have a Scar upon 'em.

Having explain'd the Sense of *Touching*, we are now arriv'd at that of *Tasting*. Its Organ is compos'd of the Membranes of the Tongue. The first is a tendonous Membrane, with little *Papillæ* upon it; which like those of the Skin, are lodged in the Cavities of a *Reticular Body*. There are three sorts of these *Papillæ*. Some are like the horns of Snails; *i. e.* Their Extremity

Extremity is a little thicker and rounder than that part which is fasten'd to the tendonous Membrane. Those of this form are chiefly found on the sides and the tip of the Tongue. The second sort are interlac'd among the rest, and terminate in little Filaments. The third sort are of a conical or pyramidal Figure. They are fasten'd to the tendonous Membrane, and terminate on the surface of the Tongue, as the others do. The *Reticular* Membrane which gives passage to the Papillary Bodies, is black on the side of the tendonous Membrane, and white where it faces the outer Membrane.

In *Quadrupeds*, we observe little cones, as hard as Horn, fix'd in the *Reticular* Membrane. If you pull 'em out, they leave a Cavity. They are cover'd with the outer Membrane, which gives each of them a Sheath. 'Tis in these little horns that the *Papillæ* of the second form terminate. Men have none of those hard risings, for all their *Papillæ* terminate in the outer Membrane, in which they make several little risings.

These little horn Pyramids, which we find in some Animals, may serve to grind their Food. To conclude, the outer Membrane of the Tongue resembles what we call the *Cuticula* in the Skin.

Since the Tongue causes different Sentiments in the Soul, 'tis probable, that these different sorts of *Papillæ* serve to make us sensible of the different qualities of the Body that it touches. The distinction of Tastes depends upon those which resemble the Horns of Snails. The sense of Pain is regulated by those which resemble Filaments. And in fine, the sense of touching is occasion'd by those of a Conical Figure ;

Figure: For these come nearest to the nature of the *Papilla* of the Skin. The second sort are only twigs of Nerves, which usually produce a dolorous Sense; and doubtless the Animals which feed upon Hay, and rough Food, would have that sense of Pain, if their little *Papillæ* of this form were not guarded with little Horns. To conclude, the first sort serve for tasting; for, as the Organ of that Sense should be very sensible, so these *Papillary* Bodies are thick at the end, and very thin at the insertion. Now this contrivance promotes the gathering of the Impressions, and their communication to the Nerves. For, 'tis manifest, that the Salts of the Aliment being dissolv'd in the *Saliva*, must grate upon the little *Papilla* in a particular manner, which occasions such and such a taste.

T A B L E XVII.

FIG. 1. *Shews the Fibres pointed to the tip of the Tongue.*

FIG. 2. *Shews the same further in.*

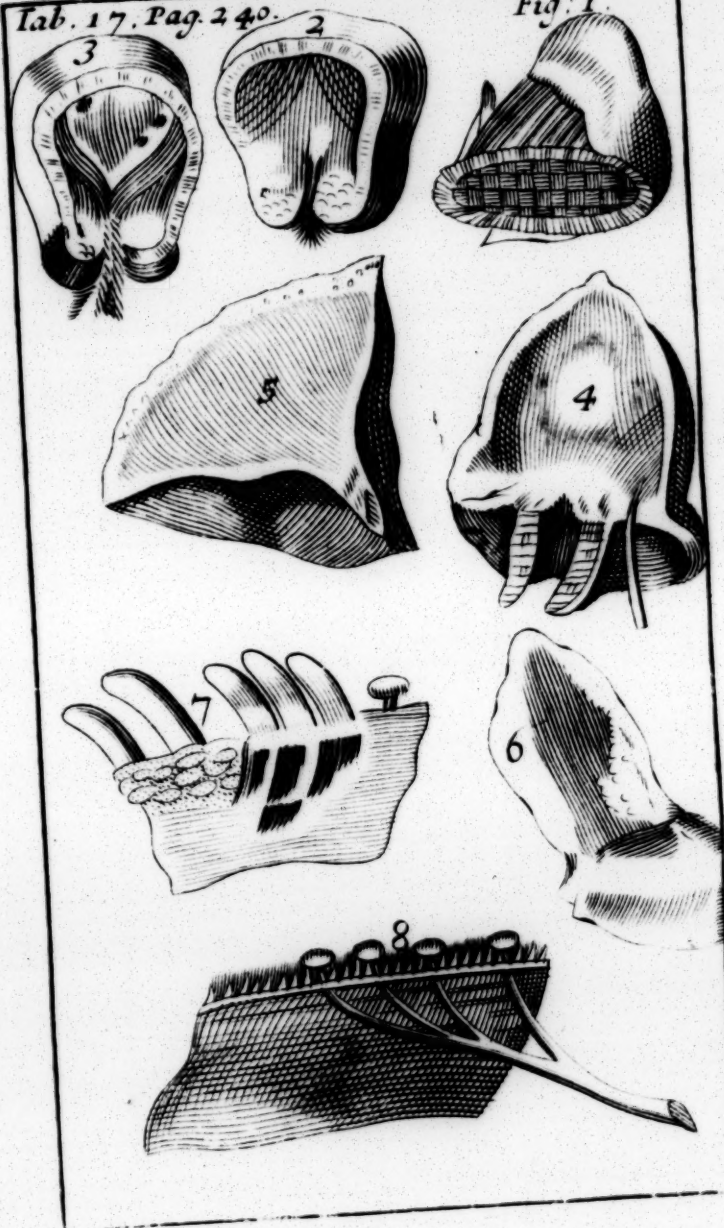
FIG. 3, 4, and 5, *are slices of the other parts of the Tongue; shewing how the Fibres are rang'd, when they approach to the Base.*

FIG. 6, 7, and 8, *Represent the Organ of Taste, and the different sorts of Nervous Papillæ, arising from the Tendonous Membrane, and passing through the Reticular Body.*

FIG. 8. *Represents some Branches of the Nerves that terminate in the Papillæ.*

Tab. 17. Pag. 240.

Fig. 1.



C H A P. XI.

Of Hunger and Thirst.

Hunger and Thirst are Sensations of the Soul, quite different from those we mention'd but now. For, Seeing, Hearing, Smelling, Tasting, and Touching, are excited by the Presence of Objects. Whereas Hunger and Thirst seem to owe their Original to the absence of Meat and Drink. Besides, the Objects that determine the Nerves and Brain to the former Senses, are external Bodies; for instance, Light by affecting the Fibres of the Optick Nerve, occasions a sense of Colours, or of Splendor, according as it is direct, or reflexive; and the various agitation of the Air occasions a sense of Sounds by striking the Nerves of the Ears. But the immediate cause of Hunger and Thirst, or that which twitches the Nerves of the Stomach, can only be lodg'd within our selves. And upon this score, the knowledge of these two Senses must be more difficult.

In treating of the original of the Chyle, I told you, that the salivary and stomachick Juices being stirr'd up and down in the Stomach, twitch the Nerves of the inner Membrane, when the aliment is deficient in the Stomach: And that occasions a sense of Hunger.

Upon this Principle, we may easily resolve several *Phænomena*. The first shall be this. When one endures Hunger for some time, it decays. This may be explain'd several ways. 1. Our Soul is more attentive to a new impression, and

Q accordingly

accordingly the first attack of Hunger is most sensible. 2. When one has fasted long, he becomes weak; and in that state the Soul is less mindful of what passes in the Stomach. Nay, in that condition, we are in a manner insensible of that, which would make us very uneasy at another time. 3. The Stomachick Juice, by fretting the Fibres of the Stomach, makes the fleshy Fibres contract; upon which the Cavity is straiten'd, and the Ferment expell'd into the Intestines.

The second question that seems to merit an Answer, is this. Why does Drinking take away Hunger; and of all sorts of Drinks, why does strong Wine seem to sink the Appetite most? As to the first part of the Question; drink disperses the Stomachick Juice, and consequently its parts cannot act so forcibly upon the Fibres of the Stomach: Besides, drinking makes that Juice pass sooner to the Intestines

But Wine has an advantage beyond other sorts of Drink; for it does not only stifle hunger for the present, but lessens the Appetite for the time to come. 'Tis probable this proceeds from the numerousness of its nourishing parts; for after drinking it, we find our selves stronger. Besides it has a particular influence in rendring the Stomachick Ferment more subtil, which makes it rub with less force against the parts of the Stomach.

The third Question may be put thus. Why do we eat most in Winter, and in cold Countries. This Question is easily resolv'd, by supposing that the cold Air has a greater quantity of Nitrous parts, which mixing with the Blood and Stomachick Juice, render their parts more massy and keen, and consequently more capable to gall the Membranes of the Stomach with more force. Under

Under the Head of *the forming of the Chyle*, I told you likewise, that Thirst is occasion'd by the jogging of the Nerves of the Stomach. This jogging motion is caus'd by the combination of the Salts of the Salivary Juice, which makes the Fibres of the Nerves and Membranes to be less supple. Besides, these Salts make a slight coagulation of the Liquors contain'd in the little Glandules of the inner Membrane of the Stomach and Gullet: Which occasions a small obstruction, and renders the parts less pliable.

The first Question that occurs upon this head, is this. Why does not simple Water quench thirst, as well as when 'tis mix'd with sower Liquors. For answer, I told you that Thirst consists particularly in an obstruction of the Glands of the inner Membrane, occasion'd by the lesser distance of the Salts in the Salivary and Stomachick Juice. 'Tis true, Water may separate and dilate the Salts of the Stomach; but its parts are not penetrating enough to insinuate themselves into the pores of the little Glands that are stopp'd. But when they're arm'd with some acid Salts, they easily compass that end. Besides, the Bile, which is one of the principal causes of Thirst, when it mixes with the Salivary Juice, is extremely mortifi'd by all Acids.

This makes way for the resolution of another question, *viz.* Why eating a little when one drinks quenches thirst better than drink alone? For, when one only drinks, the Water or Wine which run presently to the Stomach, do not stop at the little Glandules of the Gullet, and so cannot remove their Obstructions. Whereas, when we eat, the Aliment being like a Sponge that receives the parts of the Air or Wine in-

to its Pores, makes them insinuate themselves more easily into the Pores of the Glands. Besides all these good effects, the aliment squeezes the Glands it passes; and by vertue of the pressure, contributes not a little to the removal of the Obstructions.

For the same reason, warm Water quenches thirst more than cold Water, as being more penetrating.

Thirst prevails more in Summer than in Winter; by reason that the Sweating and consumption of moisture, which is then greatest, suffers the Salts of the Blood and Stomachick Juice to draw nearer one another; by which means Thirst is occasion'd.

From these Premises, 'tis plain, that almost every thing that occasions Thirst, is likewise capable, either to surcharge the Stomachick Juice with Salts, or to cause slight obstructions in the Glands of the Gullet. Of this nature are Victuals stuf with Salt or Pepper.

On the other hand, the aliment that has finer and more pointed Salts, which by consequence are capable to occasion a greater Flux of the Stomachick Juice, do create an Appetite, by removing the slight Obstructions. Such are Vinegar, Verjuice, &c.

C H A P. XII.

Of the Sense of Love,

BY the Sense of Love, I understand a desire of possessing the beloved object. 'Tis true, this meaning would reach to all the Passions. But I speak particularly of the tickling Pleasure that

that attends the emission of Seed. I told you that the Seed is thrown out, when the containing parts are distended and swell'd with Blood and Spirits. This distention renders the Parts much more sensible; by reason that the motions are communicated more easily, than when they are soft: And these motions of the Membranous and Nervous Parts, are the occasional causes of the tickling and the pleasure.

These motions in the Membranous Parts are occasion'd by rubbing the walls of the Membranes of the containing Vessels: And this Friction depends upon the agitation of the parts of the Seed. So that the more volatile parts there are in the blood, which are qualify'd to wind themselves into the Seminary Vessels, the more apt is one to love. But if there's nothing else but volatile parts, the Pleasure must be so much the less; since the motions of the volatile parts are not capable to make so strong an impression, as the motions that are made by grosser parts. Chaff burns easier than Wood, but it has not near so much heat.

Whatever enables the Seed to make a stronger and more considerable Friction, must likewise encrease the Pleasure and tickling. Besides the internal Pleasure occasion'd by the collision of the parts of the Seed with the Membranous parts of the Vessels that contain it; there's yet another tickling Pleasure arising from the rubbing of the membrane of the *Glands* against the inner Membrane of the *Vagina*. This Friction determines the Blood and Spirits, to repair more plentifully to the parts of either Sex, upon which these Parts being Spongy, swell and grow stiff, so that the *Vagina* becomes straighter, and the Yard larger, and by consequence the Friction is the greater: Besides that this inflammation

squeezes the seminary Vessels ; insomuch that the Seed being press'd, and at the same time entitl'd to a great rebound, must needs make a greater impression upon the Membranous parts, than if it had been easie in its Vessels.

By this supposition, 'tis easie to resolve, why severall Animals do not pursue this Passion but in the Spring: For, 'tis certain, that at that time the fermentation of the Seed is inflam'd, as well as that of all other Liquors ; upon which, it must needs shake and jostle against the Membranous parts more than usually.

By the same Hypothesis, we may likewise explain, how the Imagination puts the Seed in the same motion when one's asleep ; and occasions a pleasure and tickling, like that we have when awake and engag'd in the Action.

For, these Imaginations move the Blood and Spirits ; upon which they wind themselves into the Vessels of the Seed, and rarifie it ; insomuch that it rises and jostles against the Membranous parts of its Vessels, and so occasions a Sense of Pleasure.

Upon the same Foot, is the explication of this *Phænomenon* ; that Salt, Artichoaks, hard Eggs, &c. inflame Letchery ; for Salt communicates to the Seed irritating parts, such as are capable to make a stronger Friction, and give more life to the Pleasure. As for Artichoaks, hard Eggs, and all other sort of Food that by vertue of a Fermentation put the parts of the Seed in a Commotion, or by vertue of their windy parts increase their elastick Vertue, such as Pease, &c. They are likewise capable to raise the Friction.

The fatigue and action that turn the Imagination from such thoughts as might raise a Fermentation in the Seed ; and by dissipating the
Spirits,

Spirits, exhaust the matter 'tis made of; do nevertheless convey some subtil parts to the Seminary Vessels, by putting the blood in motion, and so make the Seed rub against the Vessels, &c.

Sometimes fasting and a severe Life, by agitating the Blood, produce the tickling and pleasure when one's asleep, that ensues upon the fermentations of the Seed.

C H A P. XIII.

Of the motions of the Members.

IN tracing the structure of the parts, I have often explain'd their actions; and therefore shall speak only, *en passant*, of such motions as are already treated of. We must call to mind what I told you in general of the motion of the Muscles, and the distinction I made of such motions as depend absolutely upon our Will, and such as depend only in part, and such as do not depend upon it at all. But in regard I touch'd but lightly upon that distinction, I reckon it will not be improper to resume the Discourse.

Nothing can be mov'd, without an impulse from another Body that is in motion. So that the parts of our Body cannot move, if there is not something to move 'em: And that which pushes 'em on to motion, is either one or several Bodies. Now the Motions that seem to have some dependance upon our Will and Senses, cannot be produc'd by themselves. There's a necessity therefore of some Body without us

to put us in motion, whether the Soul intervenes or not.

The continual motions that have no dependance upon the Will, must be produc'd by an action of external Bodies, but withal, such an action as does not affect the Soul by its excessive frequency ; for these motions admit of no change, and without an alteration the Soul is not sensible. 'Tis true, 'tis somewhat hard to imagine such a Machine, as will produce such admirable motions as those of our Body, by being expos'd to the uniform motion of some Liquid. But if any Man knew all the Springs, and the nature of the Liquid that surrounds us ; he would quickly discover the connexion between the motions of external Bodies, and those within our Body. This we must endeavour to examine ; and upon that principle we shall explain our motions, as if the Soul were not concern'd in 'em ; in order to have a clear view of what the Body contributes towards each motion.

We must consider that the Body is a Machine consisting of many Members. Some bones serve for supporters, and others for raisers. The Muscles are the Ropes, and the external Bodies the movers.

But to enter into the detail of these motions : We shall explain the motions of every particular Organ ; beginning with those which have little or no dependance upon our Will.

C H A P. XIV.

Of the Motions that have no absolute dependence upon the Will.

WHen a motion is continual, the mover must move without intermission: And forasmuch as the motion is independent of the Will, the mover must differ in some things from such movers as determine the Soul to what it wills.

We'll suppose then a subtil matter, that cannot enter some Pipes without receiving an impression from some external Objects, but flows into others by vertue of the sole motion of the Air or ætherial matter. The case being put thus, 'twill follow, that the external Objects which cannot push this matter into some Pipes, without exciting some sorts of Will in the Soul; will make a motion that may seem to depend upon our Will, but at the same time depends really and only upon the action of the external bodies: And the other motion which we call absolutely involuntary, will only be produc'd by the subtil matter that runs into some Pipes, according as 'tis determin'd by its own parts.

The Pipes or Passages that minister to involuntary Motions, must be more open than the others: And accordingly we find, all the Nerves that come from the *Cerebellum*, and serve such parts as are the Instruments of involuntary motion, have larger Orifices than others. Such are those of the Heart, the Lungs, and the Intestines.

Besides,

Besides, we may conceive, that since these parts have only one sort of motion, namely, *Contraction* ; and since their dilatation is only owing to the Blood, the Air, and the Excrements , over which the Soul has but little sway: Their motions must therefore be either involuntary, or at least partly voluntary, partly involuntary. Here we might resume all that was said of the motion of these Parts. But there are some other mix'd motions that want to be explain'd ; such as that of Respiration, and particularly the motion of the *Diaphragm*.

When any part is entitled to such motions, as we can retard for some time, but in time are oblig'd to put in execution ; we call 'em *mix'd Motions* , i. e. partly voluntary, and partly involuntary. Of this form is *Respiration* , which we can stop for some time, but at last are oblig'd to give way. The reason of which is this. Involuntary motions depend upon the Nerves of the *Cerebellum* , and voluntary motions upon those of the *Brain* : So that a *mix'd motion* springs both from the *Brain* and the *Cerebellum* . Now the Nerves of the *Cerebellum* cannot compass this motion by themselves : So that when those of the Brain do not assist 'em , the motion is interrupted. But for as much as those of the *Cerebellum* gather more force, and become more bent, while those of the Brain are not in action, the former will in time acquire strength enough to compleat the motion by themselves. And 'tis for that reason, that we cannot always keep in our Breath.

To go on. When by a long habit the pores of the Nerves of the Brain, are very open ; there's no occasion for a fresh impulse of external Bodies to put 'em in action. So that, we breathe without perceiving it, and consequently

quently without willing it, as when we sleep. But when there happens a new determination from external Bodies, contrary to the action of the Nerves, whether by driving the Spirits into other Channels, or any other way; in that case, we find a particular Sense in our Soul, by vertue of which, we do not breathe for some time, till the Spirits that flow incessantly from the Nerves of the *Cerebellum*, augment their number and force, and so be able to move or contract the Respiration Muscles, without the assistance of the Spirits in the Nerves of the Brain.

'Tis manifest therefore, that, notwithstanding that the Spirits of the Nerves of the Brain, which repair to the Respiration Muscles, may continue their course without our perception, that is to say, without a new determination from the external bodies; yet we can stop 'em when we will; though only for a limited time.

In the next place, we'll consider the motion of the Breast.

A just discovery of the motions of any Machine cannot be compass'd, without examining all its parts. We see the breast rises and falls. To know how that comes to pass, we must look upon every Rib, as being a *Demi-Arch*, one extremity of which is articulated to the *Vertebra*, and the other to the *Sternum*.

In Man, we find twelve *Ribs* on each side, five *true* or *long* *Ribs*, articulated immediately with the *Sternum*; and five *bastard* or *short* *Ribs*, join'd to the *Sternum*, by some Cartilages. In their lower side, there's a Furrow, along which there runs a Vein, an Artery, and a Nerve. In the Extremity that joins to the *Vertebra*, we observe a Head and an *Apophyssis*, which

which join by a sort of *Synarthrosis* to the body of the *Vertebra*, and its transverse *Apoëphysis*. All these bones lie naturally one above another, pointing from above downwards. So that when any force raises them, the breast is dilated; and when they are lower'd, the Cavity of the Breast is contracted. 'Tis to be observ'd, that the articulation of the upper Ribs is much stronger, and less moveable, than those of the lower.

The *Sternum*, or *Breast-bone* is very light, being compos'd of several Cells, cover'd with a bony Plate within and without. In Children it consists of seven or eight bones; but in adult Persons only of three. The first is that which receives the Protuberances of the *Clavicula*. The second has five or six *Sinus's* or Cavities, that receive the Cartilages of the Ribs. The third terminates in the *Cartilago Ensiformis*, which is join'd to it. 'Tis easily conceiv'd, that, when the Arches of the Ribs are rais'd, and the Cavity of the Breast enlarg'd, the external Air will be press'd and driven into the Mouth, and from thence to the Lungs; which being thus blown up, fill up the enlarg'd Cavity of the Breast. And when these Arches are pull'd down again, the Cavity will be contracted, and the Air expell'd.

When, I say, that the External Air will be squeez'd, and driven into the Mouth, and so on to the Lungs; I go upon this supposition, that there's no space to which the Air can retire with less force, than to the Lungs. When I say *less force*, I suppose, that there may be little vacancies in the Air, which are not so easily fill'd as the Lungs, by reason of their smallness.

In order to the elevation of each Rib, the Muscles being ty'd to a fix'd point, must pull it up.

Now, the *Clavicula*, and the *Spina dorsi* or Back-bone, are more immoveable than the Ribs: So that the *Serratum majus* and *minus*, the *Subclavium*, the *levator*es of the Ribs, and other Muscles, being inserted at one end in the *Clavicula* and upper parts of the *Spina*, and at the other into the Ribs; must pull the Ribs up towards the Head when they shorten themselves.

The Internal and External *Intercostal* Muscles, seated in the Intervals between the Ribs; must by shortening themselves, draw the lower Ribs up to the higher, these being immovable. Now, while one half of these Muscles pulls upwards from right to left, the other pulls upwards from the left to the right; so that their compound motion will run perpendicularly upwards: And all the use of the obliquity of the Fibres, is, that, as it enlarges their length, so it renders their abbreviation more sensible, and so entitles 'em to more force.

Though the intrinsic spring and rebound of the Cartilages of the Ribs might be sufficient to bring 'em down: Yet the Muscles of the *Epigastrium* inserted at one end in the Ribs, and at the other in the *Os pubis*, and other Muscles inserted in the *Os Ileum*, pull 'em down when they swell and shorten themselves; for these Bones are more fix'd than the Ribs. Besides, there are other Muscles fasten'd to the *Os Sacrum*, and to the Ribs, which must likewise lower the Ribs, since the *Os Sacrum* is more fix'd than they.

In fine, when these Muscles act their part, the lower Ribs being pull'd down, become in
their

their turn harder to be mov'd than the upper ones; insomuch, that, if the Intercoastal Muscles were then in action, they'd draw down the upper Ribs; by reason that the lower are at that time more fix'd than they, by vertue of the contraction of the depressing Muscles. From which we may conclude, that the Intercoastal Muscles promote sometimes the dilatation, and sometimes the contraction of the Breast. But we must not join in with the Ancients, in saying that the External Muscles serve to dilate, and the internal Muscles to depress the Ribs: For they must act jointly; and since their insertions are the same, their actions must be also the same. And indeed, I cannot perceive how the one should act separately from the other in the elevation or depression of the Ribs; for the Ribs cannot be either rais'd or lower'd by an oblique motion, from the right to the left, or from the left to the right, such as these Muscles would have if they acted separately. So that there's a necessity of a perpendicular motion, which happens when they act together.

Mr. Bayle, a *Tholouse* Physician, has offer'd some Arguments to prove that the external Intercoastal Muscles act a contrary part to the Internal; and the abbreviation of the one is contemporary with the lengthning of the other. For, if we suppose, says that Author, *a b* (in *Fig. 1. TAB. XVIII.*) to be the *Spina*, and *c d*, *e f*, the two Ribs: 'Tis plain, that if these two Ribs be pull'd downwards (as in *Fig. 2.*) the Angle *e c g* will be lessen'd, and consequently the Muscle *c g* shorten'd, as being opposite to a lesser Angle, while the sides *e g* and *e b* remain the same. On the other hand *c e b* being larger, the opposite Muscle *c b* must become longer.

longer. Thus, says our Author, since the External Intercostals *c b* serve to raise the *Costæ*, the Internal Intercostals *e g* can serve for nothing but to draw 'em downwards; since 'tis certain that these Muscles do not act or pull the parts, but when they are shorten'd.

For a second proof, he adds, that the force of any Power augments in proportion to its distance from the Center where it rests; and consequently, that the Muscle *c b* being near its resting point in the Rib *c d*, and remov'd far from it in the Rib *e f*, when it becomes shorter, 'twill have more force to raise *e f* than to draw down *c d*.

These Arguments are more Ingenious than Just. For, 1. He supposes the Ribs are parallel to one another, whereas the middle parts of the Arches are much nearer one another, than the Extremities by which they are join'd to the Back-bone; and towards the Back-bone there are more Ligaments and Intercostal Muscles. 2. To make his Reasons bear, he must suppose that when the *Intercostals*, whether Internal or External, come from any Extremity of the Rib towards the middle, they have an opposite situation to what they have before that; since besides the *Spina*, there's another fix'd point, namely, the *Sternum*, opposite to it: Or else that half of the External Intercostals that lies towards the *Sternum* must act along with that half of the Internal Intercostals that lie towards the *Spina*, and so reciprocally. But the Intercostal Muscles do not change their Situation; and it is not at all probable, that the Fibres of one Muscle have opposite actions. We must therefore own, that the *axis* of the traction of the external Intercostal Muscles has its fix'd point towards the *Sternum*,
and

and that of the Internal, towards the *Spina*: From which 'tis a necessary consequence, that the result of their oblique actions, is a perpendicular motion.

I shall not insist on the Respiration of Brutes: But only observe, that in such Animals as run much, and very swiftly, their Ribs are pull'd very low, which enables them to make a more considerable arch when they are lifted up, and to drive more Air into the Lungs.

Since the office of the *Diaphragm* is so hard to be understood, I thought it not improper to make a particular enquiry into it, and into the manner in which it contributes to Respiration. Some Anatomists have look'd upon the *Diaphragm* as a Membrane toss'd by the motions of the circumambient parts. In their opinion, when the Lungs are blown up, the *Diaphragm* is reduc'd to a flat even Figure; and when the Muscles of the Abdomen exert their Power, they push up the *Viscera*, and make the *Diaphragm* rise up to the Breast. This is the consequence of the supposition, that it is a simple unactive Curtain. But when we come to know that it is a double Muscle, we'll quickly drop that opinion.

The Midriff is seated between the Breast and the *Abdomen*. 'Tis ty'd to the lower part of the *Sternum*, and of the Ribs. In the middle, it has a broad *Aponeurosis*, i. e. a sort of Membranous Tendon. Towards the Breast, 'tis cover'd with a Membrane, which is a continuation of the *Pleura*. Towards the Abdomen, 'tis cover'd with another, which is a production of the *Peritoneum*. On this side, it has two Productions or Ligaments, which are fix'd along the *Vertebrae* of the Loins. On that side which faces the Breast, 'tis ty'd by a Ligament to the *Pericardium*.

Pericardium. But this Ligament is not found in four-footed Beasts. Its second Muscle gives passage to the Gullet and the Stomachick Nerves. The *Aorta* and the *Thoracick duct* pass between the productions of the *Diaphragm*; and the *Cava* passes through its tendinous part. The first Muscle is of a circular Figure. 'Tis ty'd to the Ribs, and terminates in a Tendon that's common to it and the second Muscle. This second Muscle comes from the *Vertebrae* of the Loins, and terminates in the *Aponeurosis*. *Bartholin* observes that the upper Muscle, after its connexion with the *Costae*, has Fibres fasten'd to the transversal Muscles of the *Abdomen*. These two Muscles receive Arteries from the *Aorta*; their Veins open into the *Cava*; they have some Lymphatick Vessels that run into the *Thoracick duct*; and several Nerves deriv'd from the second Vertebral Pair, and the eighth of the *Medulla oblongata*. 'Tis by these last Nerves, that some alledge, the *Diaphragm* communicates with the Lips and the Face. We observe two motions in the Midriff, in one of which it bends Archways into the Breast; and in the other it returns to a level. 'Tis question'd, whether its Fibres are bended in the first or the second motion. Some think it exerts its Musculous Power in 'em both. But, since all its Fibres conspire to the same action, we cannot imagine how it should be capable of two such different actions.

Others think that it only acts in expiration and when 'tis bended like a Vault. Their Reasons are these. 1. When a Muscle acts, it pulls the part to which 'tis fasten'd; but when the *Diaphragm* enters the Breast, 'tis shorter, and draws down the *Costae*: Therefore it then acts a Muscular part. 2. It expells the Air out of

the Lungs with a great deal of force, as well as attracts the Ribs; which it could not do if that were not the time of its action. Besides, when a Muscle is seiz'd with Convulsions, 'tis then in action; but in the Hiccough, which is a Convulsion of the Midriff, it expells the Air; therefore it acts as a Muscle when it expells the Air, *i.e.* in Expiration, when 'tis vaulted into the Breast.

All these Proofs are too weak to sway an unprejudic'd Person. If the Diaphragm drew in the Ribs, as it enters the Breast; it must have a resting place and an insertion in the Breast, more fix'd than the Ribs. Now, since it has no such thing, it cannot mount up to the Breast, without being push'd by the *Viscera* that surround it; and by consequence that's not the time of its action. In short, how can it be lifted upwards by the action of its Fibres; since they are straight when they swell, and consequently must needs level it? It may be objected, perhaps, that when the *Abdomen* of a Dog is open'd, though the Muscles of the *Abdomen* do then cease to raise the Diaphragm, by beating in the *Viscera*, yet it still rises. I answer, that the Ribs being then pull'd down, oblige it to rise and form an Arch. This answer will likewise satisfy a second Objection, *viz.* That the Ribs are not then lower'd, because the Diaphragm bends then into the Breast. For, when they fall down, they oblige it to an Arch-like Figure: And since all concurs to contract the Breast, it must expel the Air. As for the other part of the Objection, I deny that the Hiccough is contemporary with the Expiration. Nay, on the contrary, I alledge, that the noise of the Hiccough happens in the time of Inspiration; which is easily observ'd in such Animals as chew the Cud. The

The *Diaphragm* therefore is a Muscle, which only acts by an abbreviation: Which it cannot do without being upon a level. Then indeed it presses and pushes the *Viscera*, and heaves up the Belly, till the Muscles of the Abdomen becoming shorter, and squeezing the *Viscera* in their turn, drive 'em into the Breast, by pulling down the *Costæ*: And when the *Costæ* are lower'd, the *Diaphragm* is driven up into the Breast, from which it expels the Air of the Lungs thro' the Windpipe.

It may be objected, that if the *Diaphragm* is abbreviated in Inspiration, it should pull down the Ribs at the same time, which is contradicted by Experience, since at that time we see 'em rise.

I answer, that the levelling of the *Diaphragm* will not pull down the Ribs, though its Fibres are swell'd; unless the swelling abridges their length, more than its being bent arch-ways into the Breast. Now, the levelling of the *Diaphragm* retrieves the length, that the bending of its Fibres had sunk: So that all its force is display'd upon the *Viscera*; and accordingly it squeezes 'em, turns out their Excrements, renders their Liquors fluid, and makes the Muscles of the *Abdomen* jet out. For, the *Diaphragm* is an opposite Muscle to those which lower the Ribs, that is, to the Muscles of the *Abdomen*, since it pushes down the Bowels, and makes 'em rise outwards; and on the other hand, the Muscles of the *Abdomen* repulse the *Viscera*, and squeeze up the Midriff into the Breast.

TABLE XVIII.

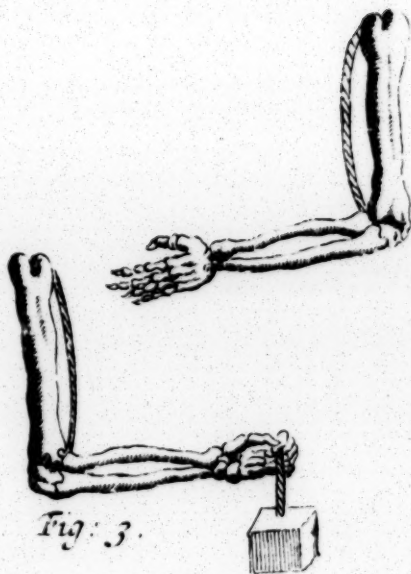
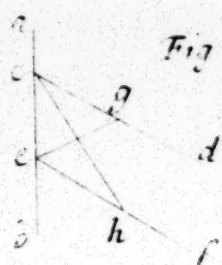
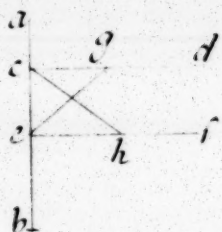
The first and second Figure are referr'd to in this Chapter.

FIG. 3. and 15. are referr'd to it in Chap. XVII. and XVIII.

CHAP. XV.

Of Speech.

HAVING trac'd the manner of the ingress and egress of the Air in the Body : We come now to consider what modification it receives there. The Windpipe, thro' which it passes, is Cartilaginous, and in a manner Elastick : so that, being briskly jogg'd, it causes a motion and collision of the Air, which makes such an impression as a sound. This is what we properly call *Voice*. There are three sorts of Voice, namely, *crying-out* or *Screeking*, *Singing*, and *Speaking*. A simple Voice or *Crying*, is caus'd by the subtil motion of the Air, arising from the sudden trembling of the Cartilages of the head of the Windpipe. Now this sudden trembling is occasion'd by the violent and rapid motion of the Air, in its egress from the Lungs. And the swiftness of the motion owes its rise to the contraction of the passage, which obliges the Air when expell'd by the Lungs to accelerate its pace ; just as all Liquors augment their swiftness, in proportion to the narrowness of the passage, and the greatness of the impelling force. The *Larynx* is straitned by the Muscles, that I am about to describe. When this constriction is all over the
same





same, it makes only a simple note which we call crying.

Some Moderns have explain'd the Contraction of the *Aspera Arteria*, by the Contraction of the *Recurrent Nerves* : But 'tis not probable that the Nerves move the parts, without the mediation of the fleshy Fibres.

The Harmonious Voice, or *Singing*, is the product of different notes or simple Voices.

An Articulate Voice, or *Speech*, is a simple Voice, modified in the Mouth, upon its Exit from the *Larynx*, by the means of the Tongue, the Lips, the Teeth, and the Palate.

The *Larynx* is the head of the *Aspera Arteria*, which is compos'd of Cartilages, Muscles, Membranes, Vessels, and Glands. It has five Cartilages.

Scutiformis, The first resembles a Buckler, and possesses the forepart : It has
or
Thyreoides. some productions both above and below. By the upper productions

tis ty'd to the *Os Hyoides* ; and by the lower ones, to the Annular Cartilage : Which is
Cricoides. the second Cartilage of the *Larynx*, and resembles a Ring ; being broad and thick behind, but narrow before.

Arytenoides. The third and fourth Cartilage are plac'd upon the annular Cartilage, in the Cavity of the first Cartilage, and

Glottis. form an Orifice, by which the Air

Epiglottis. enters and returns. The fifth Cartilage lies above the *Glottis* or Orifice

mention'd, but now : 'Tis ty'd to the hollow part of the first Cartilage ; and is easily put down by the aliment, so as to shut the *Glottis* ; but recovers its former state by vertue of a strong rebound. All these Cartilages are united by Membranes, and enjoy the same Vessels as the rest of the *Trachea*.

The Muscles that open and shut the *Glottis*, are

either inserted at one end without the *Larynx*, or else fasten'd at both ends to its Cartilages.

Those which have one insertion off from the *Larynx*, are two on each side. One *Bronchicum*. is fix'd to the upper part of the *Sternum*, and gliding along the *Bronchia*, is inserted at the other end in the underside of the *Thyreoides* Cartilage. The other is fasten'd at one end to the underside of the *Os Hyoides*, and at the other to the underside of the *Thyreoides* Cartilage.

The Muscles that have both their insertions in the Cartilages of the *Larynx*, are nine in number, viz. four on each side, and an odd one.

The first is inserted in the upper and backpart of the Annular Cartilage, and the other end is fasten'd to the upper and lateral part of the *Scutiformis*.

The second rises from the forepart of the Annular Cartilage, and terminates in the lower part of the *Scutiformis*.

The third has one end fasten'd to the inner and lateral part of the Annular Cartilage, and the other to the lower and lateral part of the *Arytænoides*.

The fourth has one end inserted into the forepart of the *Scutiformis* Cartilage, and the other in the side of the *Arytænoides*.

The odd one, is fasten'd at one end to the Place where the *Annular Cartilage* and the *Arytænoides* joyn; and at the other to the upper part of the same *Arytænoides*.

The offices of these Muscles are easily found out : In the first place, since the *Sternum* and the *Os hyoides*

oides are more fix'd than the *Cartilago Scutiformis*: The first common Muscle will draw the *Scutiformis* towards the Sternum, and consequently downwards, which cannot be done without enlarging its upper part a little. And the second will draw up the *Larynx* towards the *Os hyoides*; and consequently will dilate the lower part of the *Larynx*, and straiten the top of the *Scutiformis*, since it cannot make it rise perpendicularly.

As for the proper Muscles, or those which are inserted both ways in the *Larynx*: The first, by contracting it self must shut the *Thyreoides*; for the Annular Cartilage is immoveable, and therefore it must draw the Lateral part of the *Thyreoides* towards the upper and hinder part of the *Annular Cartilage*, by which means the *Thyreoides* is unavoidably shut. The abbreviation of the second Muscle pulls the Lateral part of the *Scutiformis* towards the fore part of the Annular, and so dilates the *Scutiformis*. The third dilates the *Rimula*, by separating the *Arytanoides* Cartilages, and drawing them near the Annular. The fourth and fifth pull the same *Arytanoides Cartilages* inwards, and consequently shut the *Glottis*, by putting them together.

This suppos'd; 'tis easily imagin'd, that, the Muscles which dilate the *Larynx*, are abbreviated when a grave Note is form'd; and those which shut it are shorten'd in order to form a sharp Note. The little quiverings of the *Epiglottis* contribute much to the harmony of Sound. But the tremblings of the Air is not caus'd by the trembling of the *Uvula*, as some Moderns alledge; for the *Uvula* is a production of the Membrane of the Palate, which has little or no rebound.

In an Articulate Voice, we distinguish the *Guttural* Syllables, from the *Lingual* and *Labial*. The *Gutturals* are form'd by the contraction of the

Muscles of the Throat ; the *Linguals*, by the motion or posture of the Tongue ; and the *Labials* by the motion of the Lips.

The Tongue has several sorts of Muscles. Some are the Fibres of which 'tis compos'd. Others only terminate in it. Of this last sort, there are eight, four on each side. The first is *Styloglossum*. fasten'd at one end to the *Apophysis Styloides*, and by the other to the middle of the Tongue. 'Tis plain, that when it shortens it self, it must pull the Tongue upwards. The second is fasten'd at one end to the inner side of the Chin, and at the other to the Root of the Tongue, and its contraction pulls the Tongue out of the Mouth. The third is united to the underside of the *Os hyoides*, and the root of the Tongue ; and by its contraction draws the Tongue nearer that Bone, and pulls it back-wards and downwards. The fourth is fasten'd to the *Cornu* of the *Os hyoides*, and by the other extremity to the side of the Tongue ; so that when it contracts it self, it pulls the Tongue aside.

By the successive contraction of all these Muscles the Tongue may be turn'd round. By the combination of the streight motions of its Muscles, it is entitled to several streight and winding motions. But that motion by which it folds it self several ways, is only owing to the contraction of the Fibres of which 'tis compos'd. There are three sorts of Fibres in the substance of the Tongue, which run length ways from the root to the Lip. The first run from the Root to the Lip, passing thro' the middle of its substance : And, when they are contracted, pull the Lip towards the Root. The second sort run length ways on the right side, and by contracting themselves pull the Lip to the right side. The third sort lie on the

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the left side, and pull the Lip to the left. Besides these *Longitudinal* Fibres, there are some *Transversal* Fibres, which run across from one side to the other. These cut the first at right Angles, and are interwoven with them. In contracting themselves they make the Tongue longer and rounder, by encreasing its thickness, and sinking its flatness. There are other Fibres that cut the *Longitudinal* and *Transversal* at oblique Angles. These, by contracting themselves, pull the Tongue towards its Root. In fine, there are others that run perpendicularly from the top to the bottom of its thickness. These bring the upper part of the Tongue to the lower, and render it thinner, broader, and flatter.

The Root of the Tongue is fasten'd to the *Oxyoides*, which is partly cartilaginous, partly bony. 'Tis shap'd like a fork; and by its horns which lie pretty open joyns to the Cartilage *Thyrooides*. 'Tis divided, as 'twere, into several pieces. That side of it that faces the Tongue is convex. It is furnish'd with Muscles to move it, so that the Tongue which is ty'd to it has some motions common to them both: And the motion is so much the easier that the Tongue has less resistance.

Of the Muscles, inserted in this Bone, and capable to move it, there are five on each side. The first is inserted into the inner side of the Chin, and by the other end is fasten'd to the *Basis* of this Bone. The second is fix'd at one end to the *Sternum*, and then rises up along the *Aspera Arteria*; and at last is inserted into the same *Basis*. The third is inserted into the inside of the Jaw, near the great Grinders, and terminates in the same *Basis*. The fourth rises from the

Geniohyoidæum.

Sternohyoidæum.

*Milohyoidæum. Cora
sahyoidæum.*

the process *Caracoides*, and after 'tis split into two Bellies, is inserted into the Horn of this Bone. The fifth is fasten'd to the *Stylo-Cerato*: the *Styloides* process, at one end; and at the other to the Horn of the *Hyoidea*. This Muscle is perforated, and serves for a Pulley to the *Digastrick* Muscle, that passes thro' it. The first pair of these Muscles, pulls this Bone and the Tongue up and forwards. The second pulls it down. When the right Muscle of the third pair acts separately, it draws this Bone upward and to the right. But when it acts in concert with its fellow Muscle, it only pulls upwards. The fourth pair acting jointly draw the Bone down. But when they act separately, the one pulls to the right, and the other to the left. Of the fifth pair, one pulls obliquely to the right, and the other obliquely to the left; when they act separately.

The Lips are mov'd by Muscles peculiar to themselves.

The Muscles of the Lips, are either *common* to them and the Cheeks; or proper and peculiar to the Lips. Of the proper ones, there are four, two on each side. The first is fix'd at one end to the Cavity of the Jaw, under the Cheek Bone, and at the other to the upper Lip. The second is fasten'd at one end to the Basis of the Chin, and at the other to the upper Lip. These two Muscles together with those of the other side corresponding to them make the four Muscles proper to the Lips. The first serves to draw up the upper Lip, and the second pulls it down. When the Muscle of the right side acts separately, the elevation or depression is oblique, and confin'd to the right side; and when the left Muscle acts, 'tis so on the left side. To these four proper Muscles,

cles, we may add a fifth, namely, a *Sphincter* that encompasses the Lips, and serves to contract them.

There are eight common Muscles; four on each side.

The first is fix'd at one end to the *Zigomaticum. Zigoma*; and at the other, to the joining of the two Lips: So that it widens the Mouth when it contracts it self.

The second is fix'd to the Gums near the Grinders, and terminates in the Lips. It serves to draw the Cheeks into the Gums, and to squeeze the Glandules of the inner Tunicle.

The third is fasten'd to the Cheek Bone, and to the under Lip; which it pulls up by contracting it self.

The fourth is fix'd at one end to the Chin, and at the other to the under Lip, which it draws down to the Chin.

The motion of the lower Jaw is likewise very serveceable, in promoting a clean pronounciation of words. Before we ingage in the examination of its Muscles; we must consider that 'tis made up of two sides, which are called *Bases*; and are sever'd in Infants by a great Cartilage in the middle, which is call'd the *Symphysis* of the Chin. In each Base we find a hole, for the passage of a Vein, an Artery, and a Nerve, which are distributed among the Teeth. The Vein runs into the internal Jugular, the Artery springs from the external Carotid, and the Nerve is deriv'd from the fifth pair. Besides the *Basis* of the Jaw, we must take a view of its Branches, and the Angles they make with the *Basis*. In each Branch we find two processes. The first is slender, and has the Tendon of the *Crotaphites* Muscle fix'd to it. This is called

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led *Apophysis Coronoides*. The other is Broad and round, and is articulated in the Cavity of the *Os petrosum*, by vertue of which it is enabled to move every way. 'Tis true in some Animals it can only move up and down, because 'tis articulated by a sort of *Synarthrosis*. 'Tis call'd *Condylodes*, bring a sort of Knot or Knee form'd by the Bone.

The Muscles that move the Jaw, are in number six on each side. The first is fasten'd by its winding and inner Surface to the Bone of *Crotaphites*. the *Sinciput* and the Cavity of the Temples. After that it gathers its Fibres into a Wreath, and passing under the *Zygoma* is inserted by a tendon into the *Apophysis Coronae*. It pulls up the Jaw, when it contracts it self; and its force is considerably augmented by the length of the sloping *Apophysis*, in which it terminates, by reason that the place of action is so far the more remov'd from the resting center.

And for this reason, the Jaw grinds with greater facility, when the Aliment is lodg'd in the roof of the Mouth, than when they are lodg'd in the forepart. For, in the first case, they lie near the Center of rest; in the other, their distance from the same point renders their resistance more invincible. This will easily appear, if one suppose the Jaw to be a Ballance, the resting Center of which is at one end, the power between that Center and the Weight, and the Weight at the other end.

*Pterigoi-
daum.
Internum.*

The second Muscle is fasten'd to the *Apophysis Pterigoides*, and at the other end to the Corner of the Jaw. It assists the *Crotaphytes* in shutting it.

Latum.

The third is ty'd at one end to the *Clavicula* and the *Sternum*, and at the other to the Basis of the Jaw: Which, being

being more moveable than the *Clavicula* or *Sternum*, is pull'd down by its action.

The fourth is inserted into the *Apo-Digastrium. physis Styloides*, and pass'es thro' the *Syloceratohyoidæum*. It has two Bellies; and at the other end is fasten'd to the inside of the Chin. It serves to pull down the Jaw; for the Muscle thro which it pass'es, do's the office of a Pulley, that changes its Line of motion.

The fifth is ty'd at one end to the *Masseter*. Cheek Bone and the *Os jugale*; and at the other to the middle and the corner of the Jaw. It pulls the Jaw aside and forwards. When it acts in concert with its companion, it pulls it simply forwards; for the one withstands the Lateral traction of the other, but does not oppose its motion forwards.

The sixth is knit to the *Apophysis Pterigoidæum. rigoides*, and terminates in the *Inter-Externum*. It passes between the *Condylus* and the *Corone* of the Jaw. It pulls the Jaw forward, as well as the *Masseter*. So that upon the whole, there are two Muscles that pull up the Jaw; two that draw it down; and two for pulling it aside and forwards.

To return to the nature of an Articulate Voice: We must consider, that all words are compos'd of one or several Syllables. The pronunciation of Syllables depends upon the pronunciation of Consonants and Vowels: For Vowels alone make no Articulation, and Consonants cannot be pronounced without Vowels; *i. e.* Vowels are Sounds, and Consonants are Articulate Sounds.

I shall not insist on the manner in which Vowels and Consonants are form'd. Several Authors have done justice to that Subject. Besides 'tis easily found out. 'Tis sufficient to say, that all words

words are form'd by certain particular motions of the Lips, the Tongue, and the Throat. Pursuant to this account, we sometimes meet with Deaf People, that can understand what another says by the motion of his Lips. But that's more common in *France*, and *Italy*; than in the Northern Countries, where they speak so much thro the Throat.

C H A P. XVI.

Of the Motion of the Head.

ALL the the motions of the Body depend upon the various Articulations of the Bones, for the Muscles act according to their junctures. 'Twill therefore be proper to take a view of the Articulation of the Head with the first *Vertebra*.

The Bone of the *Occiput* has two Protuberances which are receiv'd by the two Cavities of the first *Vertebra*. These are joyn'd by an Articulation, that admits only of one sort of Motion, namely, forwards and backwards. Tho' we think that the Head turns it self round every way, yet it do's not turn alone : For the first *Vertebra* turns upon the second along with the Head. For this second *Vertebra* has an *Apophysis* call'd the Tooth, which, after passing thro' a hole of the first *Vertebra*, is receiv'd by a *Sinus* of the *Os Occipitis*. So that the Head and the first *Vertebra*, making but one piece, are qualified to turn upon that *Axis*. There are three Ligaments that prevent the Luxation of these Bones. The first divides into halves the hole, thro' which the *Medulla* and the Tooth-like process

cess passes : And being fix'd between the *Medulla* and the Process, keeps the latter from disjoyn-
ing and pressing upon the *Medulla*. The second
Ligament ty's the first *Vertebra* to the *Os occipitis*.
The third knits the first *Vertebra* to the second,
which is immoveable ; infomuch that it permits
the first only to turn half way round; for if it turn'd
quite round, the *Medulla* might be injur'd in ob-
lique Motions. For an additional security to the
Medulla, the hole is much larger than what is ne-
cessary for it.

We come now to speak of the In-
Mastoidæum. struments for moving this Machine.

As I take it ; the Muscles that are in-
serted at one end into the *Sternum* and the *Cavicu-
la*, and at the other into the *Apophysis Mastoides* of
the *Temple Bones*, pull down the Head , when
they're contracted. The length of this Process
enforces these Muscles, because it makes a great
distance from the centre of the rest ; for it points
to the forepart of Head : For if it were plac'd
towards the hindpart of the Head, these Muscles
would move it half round, in acting separately.

As for those Muscles that raise the
Splenium. Head ; some of them are ty'd at one
end to the *Vertebra* of the Back and
Neck, and at the other to the *Os occipitis* oblique
ways : Others are ty'd at one end to

Complexum. the transversal *Apophysis* of the same
Vertebra ; and at the other to the mid-
dle of the Bone of the *Occiput*. These Muscles
have their opposites. When they act jointly,
they simply raise the Head ; but when they act se-
parately, they draw it up side ways. The

Rectum majus. other *Levatores* are fasten'd either to
Rectum minus. the first or second *Vertebra* of the Neck,
and to the Bone of the *Occiput*. The

Muscles that move the Head round, are two on
each

*Obliquum
majus.*

each side. The first is ty'd at one end to the sharp pointed Process of the second *Vertebra*, and at the other to the transversal Process of the first *Vertebra*. When they shorten themselves, they pull the transversal *Apophysis* of the first *Vertebra* towards the sharp-pointed Process of the second, which is immoveable; and by consequence turn the Head and the first *Vertebra* half round.

*Obliquum
minus.*

'Tis alledg'd, that there's a Muscle ty'd to the transversal Process of the first *Vertebra* of the Neck, which terminates in the Bone of the *Occiput*, and turns the Head half way round: But 'tis impossible it should, for the Articulation will not admit of that motion.

The oblique motions of the Head may also have some dependance upon the combination of the straight Motions: Which I shall make out in treating of the motion of the Arm.

CHAP. XVII.

Of the motion of the Spina or Back-Bone.

THE Backbone is compos'd of several *Vertebra* plac'd one above another; which being perforated through the middle, make a bony Channel, somewhat larger than the *Medulla*, or Pith, that is lodg'd in it. By which contrivance, the *Medulla* is insur'd from the harm that might otherwise accrue from the various contorsions of the Back, and bowing of the Backbone.

The *Spina* does not make a straight Line
The.

The *Vertebra* of the Neck bend inwards; and those of the Back bend outwards, and so enlarge the Cavity of the Breast. Those of the Loins bend inwards, and so bear up the weight of some Bowels. The *Os Sacrum* bends outwards, arch-wise, and enlarges the capacity of the *Hypogastrium*. The *Coccyx* shoots inwards, and serves to support the *Intestinum Rectum*.

The number of the *Vertebra* is uncertain, for it varies in different Subjects. However, we commonly allot seven to the Neck, twelve to the Back, and five to the Loins. According to this computation, there are twenty four *Vertebra*. The *Os Sacrum* is compos'd of five pieces, and the *Coccyx* of three.

The *Vertebra* are thickest towards the *Os Sacrum*; for they grow thinner as they approach to the Head. Each *Vertebra* has seven Processes, namely, one sharp-pointed, two transverse, two oblique ascending, and two oblique descending. 'Tis to be observ'd, that the two oblique descending Processes of the upper *Vertebra*, join with the oblique ascending Processes of the next *Vertebra* under it: By virtue of which union, they make two Channels on the sides of the *Vertebra*, which contain the Vertebral Veins and Arteries. The *Vertebra* are join'd one to another by great Cartilages and Ligaments. The Body of each *Vertebra* has little notches, so contriv'd, that those in the lower part of the upper *Vertebra* join those in the upper part of the next lower *Vertebra*; and so make holes between the articulations for the passage of the Nerves among the oblique Processes. The posture of the Processes, and the Figure of the *Vertebra*, gives us to know, that, since the acute Processes leave some room betwixt 'em, and the Cartilages yield a little, the

Back-bone is allow'd to bow it self forwards and backwards : And on the other hand, since the oblique Processes leave but a little Interval, the *Spina* cannot bend to the right or left.

Tho' each *Vertebra* bows but a little, yet the bending of the whole *Spina* is sensible : Just as the small Segment of a great Circle appears to be almost straight, though in Conjunction with the other parts, it makes a great Arch. However, since 'tis impossible to adjust all the motions of the *Spina* at once, we shall begin with those of the Neck apart.

I have already explain'd the articulation of the first and second *Vertebra* with the Head. 'Tis further observable, that the first *Vertebra* has a bony Protuberance, which prevents the pressure of the Vertebral Artery when the Head is pull'd backwards. In the *Vertebrae* of the Neck the Transversal Processes are perforated ; which is all that's peculiar to them. They have four Muscles to pull 'em forward, and four to erect or to pull 'em back. *i. e.* On each side there are two bowing Muscles, and two that erect the *Vertebra*. The first of the former

Longus. fort is fasten'd by one end to the third *Vertebra* of the Back, and by the other to all the *Vertebrae* of the Neck. Since the inferiour *Vertebrae* are always less moveable than the upper ones, this Muscle cannot but pull the upper *Vertebra* downwards, and so bow 'em. The second of the incurvating Muscles is

Scalenum. shap'd like a *Scalenum*, or a Triangle of unequal sides. One part of it is fasten'd to the *Clavicula*, another to the second Rib, and a third to the transversal *Vertebrae* of the Neck. When the Erectors of the *Vertebrae* of the Neck are contracted, the *Scalenum* only lifts up the second

cond Rib; but when the bowing Muscles are shorten'd, it assists 'em; for the *Vertebrae* are more moveable than the *Claviculae* and upper Ribs. So that this Muscle does not raise the Ribs, but when the Neck is erected; and therefore 'tis no wonder if in a difficulty of Respiration, we hold up our Heads, in order to imploy this Muscle, in heaving up the Ribs, and enlarging the Cavity of Breast.

There are likewise two Muscles on each side that draw back the *Vertebrae*. The *Transversalis*. first is knit to the Transversal Processes of the six upper *Vertebrae* of the Back, and all those of the Neck.

When this is shorten'd, it draws back the *Vertebrae* of the Neck, and so erects the part. The second is inserted into all the acute Processes of the seven upper *Vertebrae* of the Back, and terminates in the acute Processes of the five lower *Vertebrae* of the Neck. Its contraction draws the upper *Vertebrae* towards the lower.

The *Vertebrae* of the Back and Loins are mov'd by six Muscles, three on each side. The *Triangularis*. first has one end fasten'd to the side of the *Os Ilium* and the *Os Sacrum*; and the other to the Transversal Productions of the *Vertebrae* of the Loins. Since the *Os Ilium* and *Sacrum* are more fix'd than the *Vertebrae* of the Loins, this Muscle must draw back these *Vertebrae* sideways; that is, to the side on which it stands: Indeed if the corresponding Muscle acts at the same time, they'll pull 'em directly

back. The second is knit at one end to the back part of the *Os Sacrum*, and at the other to the acute Processes of the *Vertebrae* of the Loins. Now, the *Vertebrae* being more moveable than the *Os Sacrum*, are drawn back by this Muscle, and that so much

the more forcibly, that the *Spine* are long, and so enlarge the distance between the active Power and the Center where the Muscle rests. The third is fasten'd on the right side to the *Spine* of the *Os Sacrum*, and terminates in the Transversal processes of the Back. When this Muscle acts separately, it makes the oblique motions of the Body; but when it acts in concert with that of the left side, it pulls back the *Vertebrae* of the Back.

From these Premises, 'tis plain, that the *Vertebrae* of the Back and Loins have Erectors that pull the Spine backward, but we meet with none that pull it forward. Indeed, the Muscles of the *Abdomen*, by drawing down the *Sternum*, may bow the *Spina* forwards.

C H A P. XVIII.

Of the motion of the Arm, Cubit, and Hand.

THE Arm, or that part that reaches from the Shoulders to the Elbow, moves it self up and down, backward and forward, to the right and to the left, and round about. The Cubit, or that part that reaches from the Elbow to the Wrist, may be bow'd, extended, turn'd downward, which we call a prone Posture, and turn'd upward, which we call a supine Posture. The Hand is divided into the Wrist, the Palm, and the Fingers. It borrows its motions from the parts to which it is fasten'd. For instance, when the Cubit turns downward, the Palm of the Hand is likewise turn'd down; and when the former is turn'd upward, the latter is likewise

wife turn'd up. The Wrist may be bow'd, extended, pull'd in and out, and turn'd round, what by the combination of its motions, and what by the joining of the motions for the prone and supine Posture of the Cubit. The Fingers bow, and extend themselves, in three different places. They likewise draw nearer, or move further off from one another.

There's but one Bone in the Arm, but there are two in the *Cubit*; the greatest of which is call'd *Ulna*, and the smallest *Radius*. The Wrist has three Bones, the Palm of the Hand four, and the Fingers fifteen, *i. e.* three a-piece.

The bone of the Arm is large and hollow. Its upper Extremity is thick and round, and terminates in a Neck that grows a little smaller. The articulation of this Extremity cannot be well explain'd without taking a view of the *Scapula*, which is a Bone of a Triangular Shape, enjoying a concave and a convex part. In its convex part there's a Process that resembles a *Spina*. It terminates in a pretty large *Apophysis*, at the extremity of which we find a shallow Cavity. This shallowness enables the Shoulder-bone to move it self more easily upwards, downwards, and to either side. But to prevent an easie Luxation, 'tis detain'd in its Cavity by Ligaments; which, after all, would be weak ties, if the expansion of the Tendons which terminate in the Shoulder-bone did not form a sort of tendonous case that imprisons that Bone in the Cavity of the *Scapula*. And, after all, these two ties would not hold out long, if the Shoulder-bone could move it self quite backwards. For there are two *Apophysis*, in this Bone, which jet out, and hinder that motion, and withal strengthen this Articulation.

*acrocoides and
transum.*

The *Shoulder-bone* has two Prominences, and one Cavity in its lower part. One of its Processes is receiv'd into the Cavity of the *Ulna*.

The Cavity that lies between these two Prominences, receives a Process of the *Ulna*; so that the *Shoulder-bone* is join'd to the *Ulna*, by a sort of *Ginglymus*.

The second Process of the *Shoulder-bone* is receiv'd by the Cavity of the *Radius*, by a sort of *Arthrodia*; by which means the *Radius* is impower'd to move upon the *Ulna*, and this is the source of the prone and supine postures of the *Cubitus*.

The *Ulna* and *Radius* are join'd together, and plac'd one above another. They have a Triangular Shape. The Interstice between the two is fill'd up by a Membrane. The Bones of the *Cubit* are articulated in their lower Extremity to the two first Bones of the Wrist, by a sort of *Arthrodia*. The third and fourth bone of the Wrist are simply join'd to the other Bones of the Wrist; and the remaining four are join'd to the Bones of the Palm of the Hand by some Cartilages.

There are four Bones in the Palm, which are join'd by a sort of *Arthrodia* to the first row of Bones. The three Bones of each Finger are join'd by a *Ginglymus*.

However, 'tis easie to conceive the Mechanism of the motion of the Arm and the Hand.

The Erectors of the Arm, which
Deltoides, move it upwards, are plac'd on the
 outside. One of'em is fasten'd to the
Spina of the *Omaplata*, and the *Claviculae*, and
 terminates in the middle part of the
Supra-Spina- *Shoulder-bone*. The other is fasten'd
 rus. at one end to the cavity which lies a-
 bove

bove the *Spine* of the *Scapula*, and at the other to the Neck of the Shoulder-bone. Since these Muscles have their fix'd resting places above, and are seated above the Shoulder bone, when they contract themselves, they must needs raise it: But after all, this difference is to be observed, that the one, which is fasten'd to the middle of the Bone, must be much more capable to lift up the Arm, than that which is inserted into the neck of the Shoulder-bone: By reason, that it is further remov'd from the center of rest: And for that reason, if the Muscles were fasten'd to the lower Extremity instead of the upper, they would be much more capable to lift up the Arm.

The same Considerations will answer the action of the Muscles that lower the Arm. One of 'em is inserted in a Cavity of the lower side of the *Scapula*: And the other is fix'd to the Spines of the *Os Sacrum* and the Back. Both of 'em terminate in that part of the neck of the Shoulder-bone that looks to the Ribs. If these Muscles were fasten'd to the outer side of the Arm, and cross'd over the Shoulder, they would lift up the Arm: But for as much as they terminate in the inside, they pull it down. The length and breadth of the last entitles it to a stronger contraction and action, than that of the first.

Of the Muscles that move the Arm forwards, one is fasten'd by one end to the *Clavicle* and *Ribs*, and by the other, to the middle of the Bone of the Arm. The other has one end inserted in the *Coracoideus* Process of the Shoulder-blade, and terminates in the middle of the Shoulder-bone. Though they seem to be weak, yet they

act very strongly, by reason that their insertion lies at a distance from the Center where they rest, and the line of Direction comes nearer to a Perpendicular, with respect to the moving Engine.

As for the Muscles that pull the Arm backward; the first is inserted into the Spine of the *Scapula*, the second into the under part of the *Scapula*, and the third into the lower side of the same Bone. All the three terminate in the neck of the Shoulder-bone.

When all the Muscles of the Arm act successively, the Arm must be turn'd round; for the succession of the four opposite motions, *viz.* downward, forward, upward, and backward, will make a motion round about.

Besides these proper motions, the Arm has some that depend upon the *Omo-plata*: For the raising or lowring the Shoulder, raises or lowers the Arm.

The *Scapula*, or Shoulder-blade has four Muscles, one of which pulls it forward, the second backward, the third upward, and the fourth downward.

The first lies under the Pectoral *Serratus minor* Muscle, and springs from the four uppermost Ribs: From whence it rises obliquely, and terminates in the *Coracoid's* Process. Since the upper Ribs are more fix'd than the *Scapula*, this Muscle must draw it forward.

The second has several insertions. *Trapezius.* At one end it is inserted into the Bone of the *Occiput*, and the Spines of the *Vertebrae* of the Neck and Back: The other end terminates in the Basis and Spine of the *Scapula*,

Scapula, reaching as far as the *Acromium* and the *Clavicula*. The Spines of the *Vertebra* being more fix'd than the Shoulder-blade, this Muscle must pull it back by its Contraction. If the Benders of the Head acted in concert with this Muscle, the Bone of the *Occiput* being more fix'd than the Shoulder-bone, the Shoulder-bone would be drawn upward: But if this Muscle contracts it self apart, the bone of the *Occiput* will be pull'd backward.

The third is inserted into the three lowermost *Vertebrae* of the Neck, and the three *Rhomboides*. uppermost of the Back, and terminates in the Basis of the Shoulder-blade, which it draws backward and downward.

The fourth is inserted into the Transversal Processes of the four first *Vertebrae* of the Neck, and terminates in the upper corner of the Shoulder-blade, which it pulls forward, and upward.

The *Cubit*, or that part of the Arm that reaches from the Elbow to the Wrist, has four sorts of motions, *viz.* Flexion, Extension, a prone motion, and a supine motion.

Of the two Muscles that bow it, *Biceps. Brachialis Internus*. one is inserted into the Shoulder-blade, and the other into the upper part of the Shoulder-bone.

The first terminates in the Head of the *Radius*, and the second between the *Ulna* and the *Radius*. These Muscles cannot but bow the Cubit; for 'tis impossible to make the Shoulder-blade, or Shoulder-bone, move toward the *Cubit*.

To perceive the strength of these Muscles; See Tab. XVIII. let's suppose the Muscle *a m b* to Fig. 3. and 15. be inserted at *b*, its force *a n* being near the Insertion, but the weight *d* being at least

least twenty times further off. Now, there must be twenty times more force here, than if the weight and the Muscle had been equally remov'd from the centre of rest : So that a weight of ten Pound in one case, will answer two hundred in the other. And as some Men will lift an hundred weight with their Hand when they hold their Arm *Horizontally* ; so their Muscles would lift two thousand weight in a perpendicular Posture. According to this Scheme, 'tis easily explain'd, why 'tis harder to lift a Burthen when the Cubit is bended inward, than when it and the Arm make a straight Line.

As for the Muscles that extend the *Cubit* ; one of 'em is inserted into the lower edge of the Shoulder-blade, and the other in the neck of the Shoulder-bone.

Longus.
Brevis.

They terminate in the hinder Process of the *Ulna*. They extend the *Cubit*. Were it not that the Process of the *Ulna* which is articulated in the cavity of the lower end of the Shoulder-Bone, stands in the way, these Muscles would bow the Arm in an opposite way to that of the first Flexion. But 'tis plain, that *that* Process will not suffer the *Cubit* to be extended much beyond a straight Line.

The *Pronatores*, or those which turn the *Cubit* inwards, and the Palm of the Hand downwards, are two. The first is inserted into the internal Process of the Shoulder-bone, and terminates in the outside of the middle of the *Radius*. Since the Shoulder-bone cannot move this way, it must needs pull the outer part of the *Radius* inwards. The second is inserted into the lower and inner part of the *Ulna*, and terminates

Quadratus. in the lower and outer part of the *Radius*. Now, since the articu-

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culation of the *Ulna* with the Shoulder-bone, viz by *Ginglymus*, renders the *Ulna* incapable to answer a lateral pull ; and since the *Radius* is impower'd to move every way, by vertue of its articulation, which is an *Arthrodia* : 'Tis plain, that the outer part of the *Radius* may be drawn towards the inner part of the *Ulna* , upon which the Arm and the Palm of the Hand, which is fasten'd to it by the Wrist, will turn inwards and downwards. And this is what we call *Pro-natio*.

There are also two *Supinatores*. The first springs from the external Process of the *Longus*. Shoulder-bone, and terminates in the lower and inner part of the *Radius*. When it shortens it self, it turns the *Radius* and the Hand outwards and upward.

Brevis. The second rises from the external Process of the Arm and the *Ulna* , and terminates in the upper and forepart of the *Radius*. It pulls it outward , and so turns the Arm and the Hand upwards.

The Palm of the Hand has one Muscle, which is inserted in the inner Process of the *Palmaris*. Shoulder-bone, and spreads it self over the inside of the Hand , and cleaves firmly to the Skin , and not to the Bones, as the above mention'd Muscles do. It pulls the Palm inwards toward the Arm. But it neither dilates nor contracts it, for these two actions depend solely upon the Muscles that move the Fingers : Insomuch, that when the *Antithenar* and the benders are contracted, the Hand is render'd hollow ; and when the Extenders and those which separate the Fingers are contracted, the Palm of the Hand is extended.

The motions of the Wrist, are bowing, extending, and moving to the outside or inside. The Muscles

Cubitus
Internus

Muscles upon which its flexion depends are fix'd in the inner part of the Shoulder-bone, and one of 'em terminates in the Bone that supports the little Finger, whereas the other terminates in the Bone that supports the Fore-Finger.

Radius In-
ternus.

When these two act jointly, they bend the Wrist, but when they act separately, the one pulls it out sideways towards the little Finger, and the other draws it inward towards the Fore-Finger. Their Tendons pass under a strong Ligament, which we call *Annular*; by which contrivance they are kept from swelling the part when they bend the Wrist, notwithstanding that they terminate towards its Extremity; for if it were not for this Ligament that keeps 'em down, they would certainly do it.

Cubitus
Externus.
Radius
Externus.

There are also two *Extenders* inserted into the inner Process of the Bone of the Arm. One of 'em terminates in the Bone that stayeth the little Finger, the other in that which sustains the Fore-finger. They run along under the Annular Ligament, as well as the *Benders*. When they act jointly they extend the Wrist. But when they act separately, the first extends it outward, and the other inward. When the Bender that bends it inward, acts in conjunction with the Extender that extends it inward, 'tis neither bended nor extended, for the one hinders the operation of the other; but both of 'em conspire to draw it simply inward. In like manner the joint action of the other Bender and Extender, moves it outward. By the immediate succession of these motions, we may turn the Wrist round.

The Fingers are bended, extended, and drawn nearer together, or separated further.

Sublimis. The first *Bender* is fix'd to the internal Process of the *Ulna*; and passing under the Annular Ligament, is divided into four Tendons, which terminate in the second Joint of the four Fingers.

Profundus. The second is fix'd to the upper parts of the *Ulna* and *Radius*, and passes under the Annular Ligament; after which 'tis split into four Tendons, which pass through the holes in the Tendons of the *Sublimis*, and are inserted into the third Joint of the Fingers. The Tendons of these two muscles have two Sheaths, which at once hinder the swelling of the part when they pull, and filter an oily Liqueur that supple the Tendons. When these muscles are contracted they bend the Fingers.

The common Extender of the four Fingers, is fix'd to the outer Process of the Shoulder-bone, and passing under the Annular Ligament is split into four Tendons, which terminate in the third Joint of the Fingers.

The Fore-Finger has a peculiar Extender, which is inserted into the middle and outer part of the *Ulna*, and terminates in the second Joint of that Finger.

The little Finger has likewise a proper Extender, which is fix'd in the outer process of the of the Arm bone, and terminates in the little Finger.

For moving the Fingers sideways, there are little Muscles fasten'd at one end to the

Lumbricales. Tendons of the *Profundus*, and at the other to the sides of the Fingers. They act particularly when the *Profundus* acts, and bow the Fingers into the Thumb, as when we

we go to take up any thing with the ends of our Fingers.

There are six other little Muscles, fasten'd to the Bones of the Palm, and the bones of the Fingers. The bones of the Palm are less moveable than those of the Fingers; insomuch that when all these Muscles act jointly, they draw the Fingers nearer together; and if the muscle that draws the Fore-Finger into the Thumb be shorten'd, these muscles will likewise move the Fingers that way. If that which removes the little Finger from the Thumb, be then in action, they will likewise draw the Fingers from the Thumb. The Fore-Finger and the little Finger have some muscles that separate them, and others that extend 'em; which were describ'd before.

The muscle that removes the Fore-Finger from the rest, and draws it in to the Thumb, is fix'd to the first bone of the Thumb, and to the bones of the Fore-Finger, which are more moveable than those of the Thumb.

The Muscle that draws off the little finger from the rest, is fix'd at one end to the third and fourth Bone of the second rank of the Wrist, and at the other to the outside of the first joint of the little finger, which it draws outwards from the rest.

The Thumb is extended by two Muscles, which spring from the upper and outer part of the *Ulna*. One of them terminates in the second, and the other in the third Bone of the Thumb.

Some Moderns have endeavour'd to prove, that the Nails are only lays of the reticular Membrane, and of little Nipples, lengthen'd and harden'd
one

one above another by a Saline juice. To back their opinion, they alledge that the Nails do not grow more by their Roots than by their other parts. If they grow only by the Roots, say they, one part of the Nail might quit its hold, and take up with new ones. But, according to their *Hypothesis*, the Nails grow out of all the parts of the Skin. In confirmation of this opinion, *Bartholin* reports, that he saw the Nails begin to grow black at the end, and continue the growing blackness to the Roots. To explain the continuation of stains or blemishes from the Root to the other Extremity, they plead the lengthning of the lay or bed in which they are.

But after all, I take this to be a more probable account of the matter. I suppose all the Body to be a contexture of Threads of the same nature, which are only varied by the different Juices they contain; as a Tendon differs from a muscle only by the difference of the Liquors that feed and nourish 'em. So that we ought not to take the Skin and the Nails to be all one, or to be nourish'd by the same Juices, and distinguish'd from the reticular membrane, only by their hardness. Their peculiar Figure and form, takes date from the first forming of the Body.

C H A P. XIX.

Of the structure of the lower Limbs.

TO Illustrate the Structure of the lower Limbs, we must compare 'em with the upper. The Thigh answers the Arm, the Leg the Cubit, and the Foot the Hand: And as the Hand is compos'd

compos'd of the Wrist, the Palm, and the Fingers; so the Foot consists of the *Tar/us*, the Sole or *Metatar/sus*, and the Toes.

The Thigh has but one Bone, as well as the the Arm. This Bone has a large round head, which is articulated in the Cavity of the Hip-Bone by *Enarthrosis*. 'Tis ty'd fast in the Cavity by a strong Ligament; and to keep it fast, the Cavity grows narrower towards the Edges. The neck under this head is not in a straight line with the Thigh-bone. On the opposite side it has an appendage call'd the greater *Trochanter*, and a little lower another call'd the lesser *Trochanter*. In the other end of this Bone, there are two Processes, with a Cavity in the middle: By which 'tis join'd to the two Cavities and the Prominence of the *Tibia*, by a sort of *Ginglymus*.

Upon the articulation of the Thigh-bone with that of the Leg, there's a flat round bone, call'd *Patella*, the *Pan*. Some think it serves to strengthen the Joint: But if we consider that it is very loose, and withal, that it reaches above the Joint, we will readily grant that it serves for some other use.

The Leg has two Bones as well as the *Cubit*. These two Bones are almost like one another. The largest of 'em is call'd *Tibia*, and the other *Fibula*. The upper end of the *Fibula* receives a Process of the *Tibia*; and the under part of the *Tibia* receives one from the *Fibula*: By which means the Leg is only capable of flexion and extension, and cannot move to a prone or supine Posture, like the *Cubit*. In the lower end of the *Fibula*, there's an eminence, call'd *Malleolus Externus*, or the outer Ankle; and another in the *Tibia*, which is call'd *Malleolus Internus*, or the inner Ankle.

The

The *Tarsus* or neck of the Foot has seven Bones.

- Astragalus.* The first is that of the *Talus*, or the *Huckle-bone*, which is join'd to the *Tibia* and the *Os Naviculare* by *Ginglymus*.
Calcaneum. The second is ty'd to the first by Ligaments, and likewise join'd to the *Os Cubiforme*, and receives the
Naviculare. Tendon of *Achilles*. The third resembles a little Boat, and is join'd to the first, and the three *innominata*.
Cubiforme. The fourth is shap'd like a Dye. 'Tis join'd to the second, and supports the fourth and fifth bone of the sole of the Foot.

The other three are call'd *innominata* or *Cuneiformia*, i. e. *Wedge-like*. They have a broad Basis, and grow smaller towards the other end.

The Sole is compos'd of five Bones : The greatest of which supports the great Toe.

The Toes have fourteen bones, *viz.* Two for the great Toe, and three for every one of the rest. Their structure is much at one with those of the Hand. Under the Tendons of the Muscles that move the Toes and Fingers, there are little Bones call'd *Sesamoidea*. 'Tis very probable, these Bones make a small enlargement of the distance between the Muscles and the Center where they rest, which change the line of their action, like a Pulley. But this service is above all most remarkable in the *Patella*, over which the Tendons pass that stretch the Leg : For the *Patella* moving along with the Tendons, hinders their rubbing or grating against one another, and at the same time removes the direction of the Tendon from the center where it rests.

A competent knowledge of the structure of the Thigh, the Leg, and the Foot, will easily furnish us with an Explication of the different Postures, that depend upon it. All the parts of the Body are in an *Equilibrium*. Those on the right side counter-balance those of the left. The upper parts counterpoise the lower. So that the directing Line passes through the middle of the Legs. When the center of gravity is supported, we can never fall; and the broader that the Basis of the Line is that goes out from it, the more firmly we stand. When we stand upon one Foot, the Supporter is but weak; for the line of direction has only the Sole of the Foot for its Basis. When we stand a Tip-toe, or upon the Heel, we can scarce stand, because the line of direction has so small a Basis. But when we stand upon both the Feet, keeping 'em at some distance from one another, then we stand safe and firm, because the line of direction has all the space between the two Legs for its Basis.

When we bend our bodies, we put as many parts forwards, as we draw backwards, in order to keep up the *Equilibrium*; and upon that account, when one stands with his Heels against a Wall, he cannot bow his Body forward without falling. For he must bring forward his breast, and that cannot be done without stretching out backwards, to maintain the *Equilibrium*. But the Wall hinders that, and therefore the Person must needs fall.

The *Thighs* may be bended, extended, join'd or separated, and mov'd round, by different Muscles.

There are three *Extenders* fix'd to the *Os Ilium*, which terminate in the *Great Trochanter*. The Protuberancy of the *Trochanter*

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chanter withdraws the direction of their Tendons from the center of rest, which is in the middle of the head of the Thigh-bone. And the same effect is likewise promoted by the obliquity of the neck of that Bone.

There are three Benders. One of'em is fix'd to the transversal Processes of the
Psoas. Back : The second to the inner cavity of the *Os Ilium* : And the third
Iliacus. to the fore-part of the *Os Pubis*.
Pectineus. They terminate all three in the lesser *Trochanter*, which removes their direction from the center of rest, and so encreases their bending Force.

One Thigh is drawn towards the other by
Triceps a Muscle that is fix'd in three places to the *Os Pubis*, and terminates in the upper and lower end of the hinder part of the Thigh-bone.

The *Thighs* are pull'd aside, and outwards, by some Muscles, that are inserted into the *Os Sacrum* and *Ischium*, and terminate in the great *Trochanter*.
Quadrigemini.

There are two Muscles that move the Thigh round. One rises from the inner
Obturatores. Circumference of the *Os Pubis*, and is inserted into the great *Trochanter*.
 The other rises from the outer Circumference of the Share-bone, and is inserted into the neck of the Thigh-bone, after it has made a Semicircle about it like a Pully. 'Tis plain, that when these Muscles shorten themselves, they must occasion a Semi-circular motion, the one outwards and the other inwards. From which we may conclude by the by, that though the Eye may be mov'd round by a complication of straight motions, yet it may have particular Muscles set apart for that motion.

The *Legs* are bended, extended, join'd together, and pull'd asunder.

The *Benders* spring from the knob of the *Os Seminer* *Ischium*; and are inserted one of 'em into the upper and inner part of the *Semimembra-* *Tibia*, and the other into the upper and inner part of the *Fibula*. They bend the Leg towards the outer side of the *Ischium*.

As for the *Extenders*, some of 'em spring from the lower Spine of the *Os Illium*; some from the two *Trochanters*; and some again from the fore-part of the *Thigh-bone*. They unite their *Tendons*, which pass over the *Patella*, and after that are inserted into the upper and fore-part of the *Tibia*. Their *Contraction* extends the Leg; in which office they receive considerable assistance from the *Patella*, which at once prevents their rubbing upon one another, and puts 'em further off from the Center where they rest, as I intimated above.

Tho' the articulation of the Leg is by *Ginglymus*, yet it may be mov'd side-ways, both inward and outward, by a motion common to it and the *Thigh-bone*.

The Muscle that moves the Leg outwards, springeth from the Extremity of the *Membranofus*. upper Spine of the *Os Illium*, and becoming Membranous, covers all the Muscles to the end of the Leg.

The Muscle that draws it inward springs from the upper part of the *Ischium*, and terminates in the upper and inner part of the *Tibia*.

There's yet another Muscle, call'd *Popliteus*, that is thought to move the Leg outwards. It takes rise from the low-

er and outer Process of the Thigh-bone, and is inserted into the upper and fore-part of the *Tibia*. But in earnest it only bends the Leg : For , since the bone of the Leg cannot be mov'd to the right or left without it be accompany'd with the Thigh-bone ; we must therefore suppose it to be all of one piece, with reference to that motion. Now, a Muscle that has both its insertions in one bone, can never move it. This is a palpable Truth.

The *Tarsus* may be bended, extended, pull'd in, and drawn out.

There are two *Benders*. The first is fasten'd at one end to the upper and fore-part of the *Tibia* ; and pass'es under a Ligament which we call *Annular* ; after which, 'tis inserted into the first wedge-like Bone, and the Bone that supports the great Toe.

The second springs from the middle and outer part of the *Perone* ; and being carried through the fissure of the outer Ankle, is inserted into the Bone that supports the little Toe. When these Muscles act jointly, they bend the *Tarsus* : But when they act separately, the first bends it inward, and the second outward.

There are six *Extenders* of the *Tarsus*. Of the first four, two spring from the lower knobs of the Thigh, the third from the upper and hinder part of the Leg, and the fourth from the Thigh-bone. All these join in one Tendon, and terminate in the Heel. They act chiefly in leaping. The fifth takes rise from the hinder part of the *Tibia* ; and having pass'd through the fissure of the inner Ankle, is inserted into the first *Os Cuneiforme* and the *Naviculare*. The

Peroneus
Posticus.

sixth takes its rise from the upper and outer part of the *Perone*, and terminates in the *Os Cubiforme*. When these Muscles act jointly, they extend the Foot: When they act separately, the one stretches it to the inside, and the other to the outside. When the *Bender* to the inside acts in Conjunction with the Extender for the same side, they mutually withstand both the flexion and extension, and with joint force draw it inwards. In like manner, when the Extender and the Bender for the outside act jointly, they only pull it outwards.

The motions of the Toes are so insensible, and withal so conformable to those of the Fingers, that I think it needless to swell this Treatise with a description of their Muscles, and their Offices. As I take it, some reflections upon Walking, Swimming, and Leaping, will be more seasonable.

CHAP. XX.

Of Walking and Swimming.

THE center of Gravity, is that point of the Body, that being supported keeps the Body from tumbling. The line that is imagin'd to take rise from that Point, and to terminate in the Center of the gravitating Bodies, is call'd *the Line of Direction*. In Man, the Line of Direction passes along the middle of the two Legs: But in four-footed Animals, it runs between their four Feet, by reason that the center of Gravity lies there.

When

When we walk, we support our selves upon one Foot only: That is, we put the center of gravity to it, and then the *Line of Direction* runs along the Leg that supports us.

The center of Gravity is put to that Leg, either because we throw it thither by supporting the other Leg upon the Earth, or because we bend that upon which we put it. Afterwards we stretch the other Leg, so that the Line of Direction goes from the first, and the Center of Gravity falls between the two Legs. After that we advance the Breast forwards, and throw the Center of Gravity upon the other Leg, which becomes shorter in its turn, while the other grows longer. This is the way of Men's walking. Now, for that of Brutes, upon the comparison with ours.

When a Horse walks, he supports himself upon three Feet. For when one of his hinder Feet presses the Earth, it pushes the Center of Gravity into the Triangle of the other three Feet. Then he advances to make another Triangle, which supports the whole Body, while one of his Feet being free, carries on the motion. Thus he makes a new Triangle which sustains the Line of Direction, and the other hinder Foot performs the same Office that its Fellow did before.

When a Horse trots, two of his Feet are diametrically opposite, which are lifted up much after the same manner as those of a Chairman's; to the end, that one Foot pressing against the Ground, may advance the Center of Gravity to the other. I would be larger upon the other kinds of walking, were it not that they are somewhat allied to *Leaping*, which will come in the next Chapter. I shall therefore go on to Swimming, which is an action common to us and Fishes.

'Tis to be observ'd that the weight of our Body is very near equal to the like bulk of Water: And upon that Foot it would continue still in the same place of the Water: But the Head being lifted up in Swimming, the like quantity of Water does not then keep its Proportion to the bulk of the Body, so that the Body would drown, if we took our measures from the simple gravity. But Swimmers, by moving their Feet and Arms round, and by giving a Horizontal Motion to the body, lessen the gravitating motion: Insomuch that the body does not divide the Liquid underneath it; but passes every moment to different Columns of Water, and so does not stay to accomplish the division: And when they continue in one place, they beat every moment with their hands upon different parts of the Water; by which means the body buoys it self up. But the case of Fishes is not the same. Their Substance is not in a perfect *Equilibrium* with the Water. They have two bottles full of Air which they can easily dilate or contract; besides, they can make Horizontal motions, which impair the gravity very much.

When the Air is squeezed out by the Fleshy Fibres of the bladders, the Fish being then reduced to a smaller bulk, cannot keep it self in the Water, and accordingly it descends to the bottom. But when they intend to rise up to the surface of the Water, they only forbear to straiten the bottles upon which the Air, by virtue of its elastick force, resumes its place, and makes the body of the Fish lighter. Some Fishes receive this Air by a passage that leads from the *Oesophagus* to these little bladders.

Having explain'd how the Fish rises to the surface of the Water, or dives down to the bottom:

tom : We are now to enquire how it swims. The Tail and Fins of the Fish, having a pretty strong motion, and being able to support themselves against the Water, advance the center of gravity, just as Oars put forward a Boat. For the Water is the Center of their rest, which, though it changes every moment, continues still to make a resistance. 'Tis to be observ'd that each stroke of the tail or of the Fins, puts 'em out of a right line : But the succeeding stroke of the Tail or of the other Fin, retrieves it again. When the Fish designs to move to the right, it moves the left Fin very much, and the right one but very little ; just as a Waterman always moves the Oar that is opposite to the side he's bound for. And 'tis for this reason, that if you take away some Fins from one side of a Fish, it cannot swim straight.

C H A P. XXI.

Of Ascending and Leaping.

WHen one raises himself into the Air without any Supporter, the Body mounts, while the raising force over-powers the weight that tends downward ; but when these two forces come to an *Equilibrium*, the Body can rise no further : And when the descending weight is greater than the raising force, the Body comes down.

The greatest difficulty is to know, wherein the raising force consists. 'Tis alledg'd, that the Muscles which extend the Legs, after their being lengthen'd in the flexion, contract themselves
with

with a sudden impetuosity, like an elastick body that unbends it self; and that, by vertue of this contractive rebound, they communicate as much motion to the upper parts as is sufficient to push 'em upwards with a violent force; and that these upper parts dragging the lower along with 'em, produce the effect that we call *Leaping*. And for that reason, we cannot leap without bending the Legs first.

There are three ways of ascending or moving upwards. 1. When we go up by steps. 2. When we ascend a sloping plain surface. 3. When we climb a Tree.

'Tis easier to go up by steps, than upon a sloping plain surface, because both our Feet are always on a straight plain, and the Center of Gravity is supported, the Line of Direction falling always between the two Legs. But even this easier ascent is more troublesome than our ordinary walking, because the two Legs are not always upon the same Plain; and that Plain which is to receive the Center of Gravity, and the Line of Direction, is higher than the other that gives it: Thus the Leg upon the upper step is very much bended, and that upon the lower treads upon it with a great deal of force: And if the Breast be but never so little advanc'd, the Center of Gravity rests upon the upper step; and when that Leg is stretch'd it draws up the other, which being free may easily be rais'd to another higher step.

'Tis much less trouble to descend, by reason that when one Leg rests upon a lower Plain than the other, the very gravity of the Body throws the Center upon it, without needing any other effort to assist it.

An ascent upon a sloping Plain, is attended not only with the same difficulties, but with greater.

greater. For, since the Soles of the Feet do not rest upon a plain parallel to the *Horizon*, the Line of Direction is perpetually push'd backward: Infomuch that one would fall backwards, if the Breast were not bended forward, which in some measure counter-ballances the gravity of the hinder parts, which on that occasion is much augmented, by reason that the sloping Plain does not support 'em.

But above all, the most troublesome ascent is that of climbing up a Tree or a Pillar. In this action, we surround one part with our Arms; then we bow the Body, and bring our Thighs as near to the Arms as possible, and clasp round the Tree or Pillar, so that the Body is held up. Then we stretch the Body, and clasp round a higher part with our hands, and so on.

'Tis manifest, that the motions of the Thighs and Arms are extraordinary, since their clasping round a Tree or Pillar is sufficient to keep up the Body. Besides the Arms act the part of a fix'd point in drawing up the lower parts of the body: And the imploying the *Spina* or back-bone from time to time in bending and erecting the Body, enflames the Fatigue of the Action.

T A B L E XIX.

FIG. 1. *From Casserius.*

- a a. *The Body of the Lower Jaw.*
- bb. *The Body of the Os hyoides.*
- cc. *The Sternohyoideum pair of Muscles.*
- dd. *The Genibyoideum.*
- e. *The Stiloceratohyoideum.*
- ff. *The Coracohyoideum.*
- g. *The Basiglossum.*
- hh. *The Nerves of the Tongue.*
- i. *The Ceratoglossum.*
- kk. *The Stiloglossum.*
- ll. *The Sternothyroideum.*
- mm. *The Hyothyroideum.*
- n. *The Cartilages of the Wind-pipe.*
- oo. *The Digastrick Muscle.*
- pp. *Part of the Stiloides Process.*

FIG. 2. *Representing part of the Muscles of the forepart of the Body.*

- a a. *The long Muscles of the Neck.*
- b. *The Scalenum.*
- c. *The Mastoideum.*
- d. *The Vertebrae of the Neck.*
- e. *The Levator of the Shoulder.*
- f. *The Subclavian Muscle.*
- g. *The Pectoral Muscle.*
- h. *The Deltoides.*
- i. *The Biceps.*
- l. *Serratus minor.*

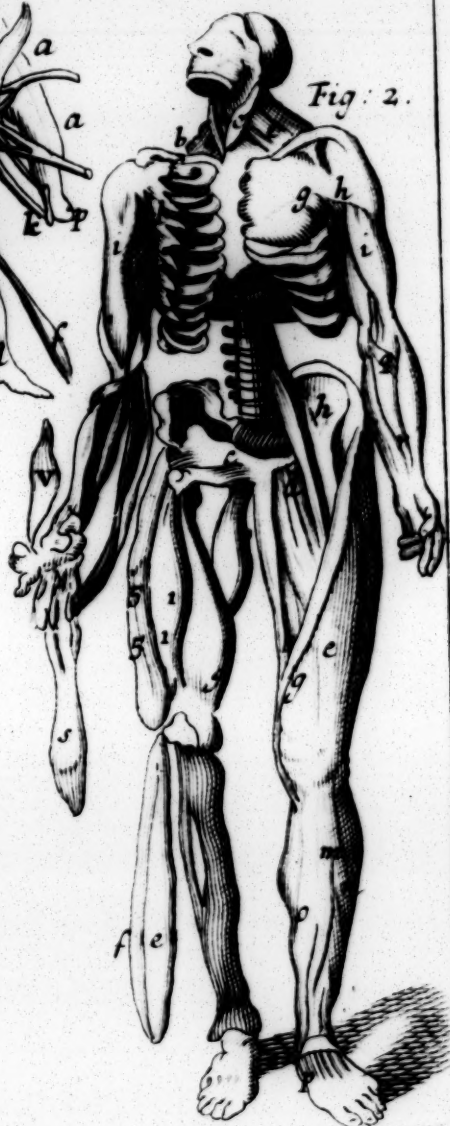
m Serratus

Fig: 1.

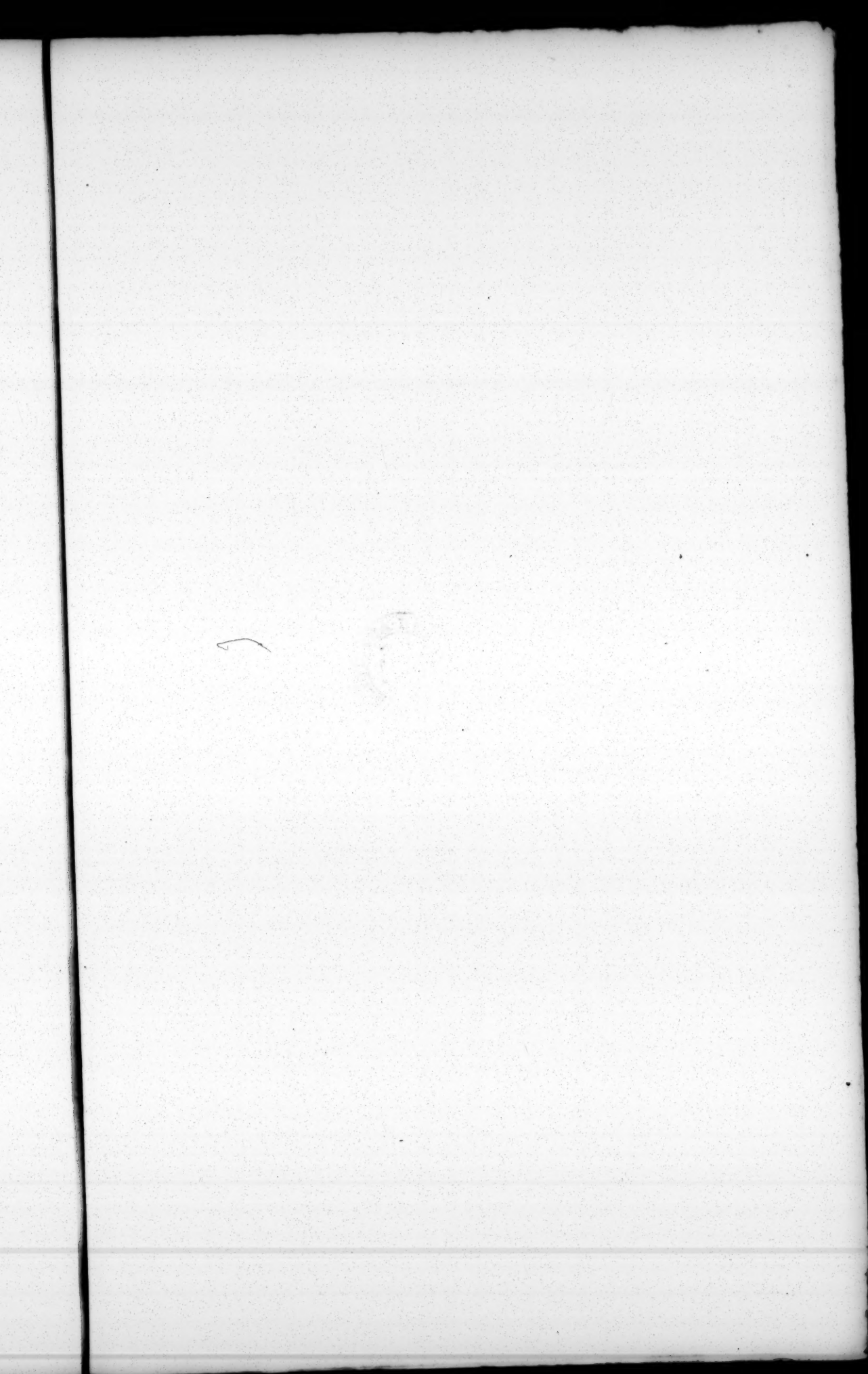
Tab. 19. Pag. 208.



Fig: 2.



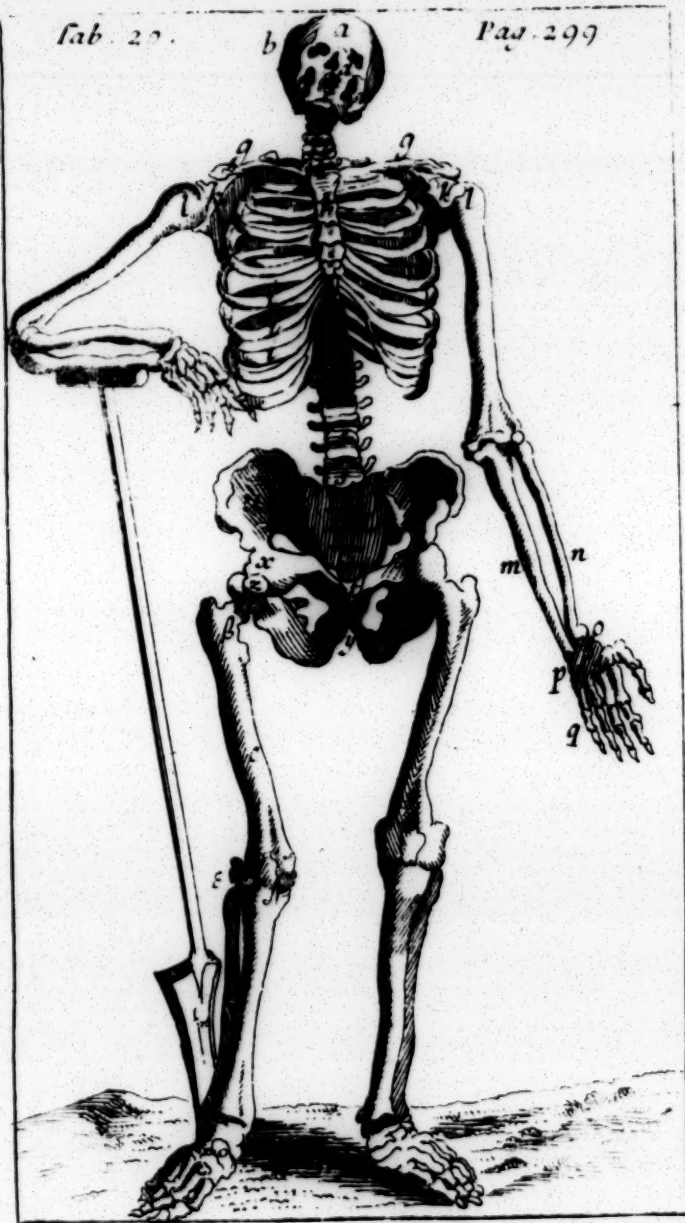




Tab. 22.

b

Plat. 299



- m. *Serratus major.*
- nn. *Intercostales.*
- o. *Brachialis internus.*
- p. *Longus.*
- q. *Pronator Rotundus.*
- r. *Palmaris.*
- s. *Sublimis.*
- t. *Profundus.*
- v. *The bender of the Thumb.*

The following Letters relate to the lower Parts.

- a. *The Psoas.*
- b. *The Iliacus.*
- c. *Obturator internus.*
- dd. *Triceps.*
- ee. *Rectus.*
- f. *Vastus Externus.*
- g. *Vastus Internus.*
- h. *Fascia lata.*
- ii. *Cruræus.*
- l. *Gracilis.*
- m. *Tibiaeus Anticus.*
- n. *The Peronæus.*
- o. *The common Extender.*
- p. *The Annular Ligament.*

TABLE XX.

- a. *The Os Frontis.*
- b. *The Temple-bone.*
- c. *The Ligonis.*
- d. *The upper Jaw.*
- e. *The lower Jaw.*
- f. *The Vertebra of the Neck.*

- g g *The Claviculæ.*
- h. *The Sternum or breast-bone.*
- i i e. *The Costæ or Ribs.*
- h h. *The head of the Omoplate.*
- l l. *The head of the Shoulder-bone, or Shoulder-blade.*
- m. *The Ulna.*
- n. *The Radius.*
- o. *The bone of the Wrist.*
- p. *The bones of the Palm of the Hand.*
- q. *The bones of the Fingers.*
- r r. *The Vertebra of the Back.*
- f f *The Vertebrae of the Loins.*
- T. *The Os Sacrum.*
- u. *The Ilium.*
- r. *The Ischium.*
- y. *The Os Pubis.*
- z. *The Head of the Thigh-bone.*
- B. *Its Neck.*
- c. *Its body.*
- d. *The Tibia.*
- e. *The Peronè.*
- o. *The bones of the Tarsus.*
- v. *The bones of the Metatarsus.*

T A B. XXI.

- a a. *The straight Muscles of the Head.*
- b. *The Levator of the Shoulder.*
- c. *The Transversal Muscles of the Neck.*
- d d. *The two Spinati.*
- e. *The Sacrolumbaris.*
- f. *The Longissimus of the Back.*
- g. *The same taken out of its place.*
- h h. *The Sacri of the back.*
- i. *The Quadrati of the back.*
- k. *The first Supinator.*

1. *The*



- l. *The Extender of the Carpus.*
- mm. *The Extenders of the Fingers.*
- nn. *The Extenders of the Thumb.*
- o. *The Glutæus medius out of its place.*
- p. *The Glutæus minor in its place, and out of its place.*
- q q. *The Pyriformis one of the Quadrigemini.*
- r. *The Obturator internus.*
- f. *the Purse in which it seems to be enclos'd.*
- t. *The fourth of the Quadrigemini.*
- v. *The Biceps which bends the Leg.*
- x. *The Semi-membranosus.*
- y. *The Semi-nervosus.*
- z. *The Gracilis.*
3. *Triceps.*
2. *Cruræus.*
4. *Tibiæus Posticus.*
5. *The great benders of the Toes.*
6. *The little bender of the Toes.*
7. *The bender of the great Toe.*

FINIS.



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